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That there is no dearth of designs for our contemplated aerial armada is evident from this presentation of some of the better known types of American aeroplanes, hyroaeroplanes, flying boats, dirigibles and kite balloons. Several of the machines shown have been used by the Allies for military and naval work, so that they are not, as a whole, new to the game of war

LEADING TYPES OF AMERICAN AIRCRAFT

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Submarine as an Anti-U-Boat Weapon

WE presume it will not be disputed that any weapon which gives promise of doing effective work against the U-boat should be thrown at once into the anti-submarine campaign. The destroyer is *par excellence* the weapon for this work, and the Secretary of the Navy, we are glad to note, has followed up his quick dispatch of our destroyer fleet to European waters by requesting an appropriation of $350,000,000 for the construction of an entirely new destroyer fleet, numbering, we presume, not less than 175 of these craft, whose ultimate appearance in the Atlantic cannot fail to be decisive.

But a fleet of this magnitude takes time to build; and the question arises as to whether there is not some other weapon of offense available, which can be thrown into the fight at once, and assist in curbing U-boat activity, and cutting down losses, during the many months that our new destroyer fleet is in the making.

We are of the opinion that such a weapon exists, ready to hand, in the vast aggregate fleet of submarines possessed by the Allied navies. At the outbreak of the war Great Britain, France, and Italy possessed, in all, some 250 submarines. What they have built since then is known only to the authorities; but a conservative estimate would put the increase at not less than 150—and it is probably greater than that. Adding to this our own fleet, built or approaching completion, and we may safely hazard the guess, that, by January 1st, 1919, the Allies will have at their disposal a total of 500 submarines.

Now Germany, for reasons known only to herself, is not building these craft at the rate which her ship-and-engine-building capacity would suggest. It is probable that their hull and engine capacity is greater than their ability to turn out the more delicate parts—the gyroscopic compasses, the periscopes, and above all the torpedoes. Possibly they are short of some essential materials—optical glass, special alloys etc. The German torpedoes, moreover, have been running very erratically of late. Cases have occurred where three or more successive misses have been scored against slow freighters.

Whatever the cause, it begins to look as though Germany is failing in her effort to cover the steamship routes so thickly with U-boats, as to be able to make a *decisive* inroad upon the merchant tonnage of the world.

If to this limited output be added the losses, not merely those due to patrol boats and armed merchant ships, but the unrecorded losses due to foundering, accident, weather and mines—a necessarily unknown quantity—it is quite possible that the total German fleet at present available is well below 500 boats, or less than the total owned by the Allies.

And so the question arises as to whether this vast Allied fleet might not be advantageously employed, the smaller craft in a close blockade of the exits from the German bases, and the larger, sea-going craft in patrol of the trade routes.

For blockade duty, it seems to us that the submarine, because of its invisibility, would be admirably adapted. By day, the line of scouts could be held below, periscope only showing, by anchoring and giving them positive buoyancy. By night they could come to the surface. Provided with the best type of "listeners" and with wireless, they would be favorably placed for detecting and following the enemy and bringing up the destroyers for attack.

Nor would the submarine be limited to mere observation. It might conceivably prove to be as effective, if not more so, in bagging the U-boat, as is the destroyer. A 4-inch shell is not so deadly as the torpedo; and there have been instances in this war of the destruction of submarines by torpedoes launched from one of their kind. These cases prove, surely, that the dictum "submarines cannot fight submarines" does not hold.

We are well aware of the difficulty presented by the fact that all periscopes look alike to a gun crew, and that the patrol on the merchant ship might open up on a friendly vessel. But surely it is not beyond the resourcefulness of the Allied navies to devise a system of night and day signals, that shall afford quick identification of a friendly boat.

To this it is objected that whatever these signals were, and however made, the Germans would learn them and use them to decoy the enemy. The answer to that would be to change the code at frequent intervals, establishing a schedule of signals, one set for each day of the week—or of the month, for that matter.

If is probable that, as matters now stand, the surface ships of the Allies have been instructed to regard every submarine as an enemy submarine. That is sound policy so long as there is no possible way by which friend may be distinguished from foe. But has the problem of devising some method of distinction been thoroughly thrashed out?

We doubt it.

Mobilizing Against Malaria

IN a notice of the epoch-making sanitary work of Gorgas on the Isthmus of Panama, published in the SCIENTIFIC AMERICAN of December 7th, 1912, the remark was made that "when malaria can be practically extinguished in such a region, the same thing can be done pretty much anywhere else." The anti-malaria campaign on the Isthmus was an object lesson by which it was naturally expected that the world at large would profit.

Sir Ronald Ross, the highest authority on malaria, calls it "certainly the most important disease in the tropics, and perhaps in the world." Thanks to Ross we have known since 1898 that malaria is transmitted by mosquitoes, and the broad lines of prophylaxis have been indicated since the date of his discovery. The details of prophylactic technique have now been worked out quite fully, and it is notorious that no intelligent and disciplined community has any excuse whatever for continuing to suffer from this disease.

What has actually been done? Strange to say, though Americans have accomplished such remarkable work in the Canal Zone, and have also waged a successful conflict with this disease in Hawaii, within the United States proper, where malaria is an economic factor of first-rate importance, effective measures to combat it have been desultory or lacking. Neither has any American institution done nearly so much toward the scientific investigation of the disease as the Liverpool School of Tropical Medicine. The medical authorities of several British tropical colonies are making an admirable fight against malaria. Taking the world as a whole, however, Sir Ronald Ross has recently declared that not more than one-tenth as much has yet been done as might have been done to apply existing knowledge concerning this disease.

A discussion on malaria took place in the section on public health and medicine of the last Pan-American Scientific Congress, one unusual feature of which as compared with international gatherings generally, was that a respectable number of its *voeux* and resolutions are actually bearing fruit. A National Committee on Malaria has been formed in the United States, whose personnel is highly impressive. General Gorgas is honorary chairman, Dr. Rupert Blue, surgeon-general of the Public Health Service, is active chairman, Dr. Seale Harris, editor of the *Southern Medical Journal*, is secretary, and most of the other members have been prominently connected with anti-malaria undertakings.

The principal formation of the committee's plans that has come to our notice is incorporated in a pamphlet by one of its members, Dr. Frederick L. Hoffman, the well-known insurance expert, entitled "A Plea and Plan for the Eradication of Malaria Throughout the Western Hemisphere." The project set forth in this pamphlet appeals to the imagination, but it is supported by statements and figures that are by no means imaginary. The annual economic loss occasioned by malaria in the United States has been estimated at not less than $100,000,000, and the annual number of cases is supposed to be something like 1,500,000. When these figures are coupled with the fact that the methods whereby the disease can be conquered are perfectly well known, it becomes evident that the national committee has embarked upon a practical undertaking of the most urgent importance.

Without attempting to review here the elaborate program adopted by the committee, involving the coöperation of a score of Government bureaus, the various state and local health authorities, the medical societies, and all other appropriate agencies, it seems worth while to quote from Dr. Hoffman's paper a remark which deserves, we believe, much more emphasis than he has given to it:

"Wherever malaria has in part been eradicated, as, for illustration, in certain localities of the Federated Malay States, on the Panama Canal, on the Suez Canal, and in Khartoum, the results achieved have been in consequence of a thoroughly organized local health administration, with sufficient *powers* to eliminate the risk of flagrant individual violation of laws, rules and regulations intended solely for the common good."

American Chemists and the War

IN modern warfare victory is assured to that country or group of countries, which command the largest mechanical and chemical resources, provided, of course, these are properly organized and are utilized to the full.

The mechanical predominance of this country has long been recognized. But in the chemical field we are by no means so strong.

It was not until German imports were stopped that we realized what a throttle-hold that country had on our food, our clothing, and even our health. The stoppage of potash imports was most seriously felt by our farmers, and this reacted immediately upon the price that the consumer had to pay for food stuffs. In the matter of dyes for our clothing we found ourselves in a deplorable state. We were absolutely dependent upon Germany for fast colors in nearly all shades. The health of the nation was imperiled by the fact that many necessary drugs could not be obtained.

Although Germany may not have had a sinister purpose in obtaining this control of our food, clothing and health, it exploited the coal-tar industries with the purpose of having available in time of war, all the apparatus necessary for the production of explosives in large quantities. A dye factory is really a peace-time explosives factory, for it takes only a few days to convert the machinery with which delicate shades of color are made into that with which the most powerful modern explosives are produced.

It is indeed fortunate that we were not thrown into a struggle with Germany at the very outset. We have had time to learn our lesson and to prepare our industries for the part that they must play in the present war. The National Exposition of Chemical Industries, held in New York, last week, shows how wonderfully America has responded to the demands for chemical development since the outbreak of the European struggle.

In 1914 there were but five companies undertaking to produce aniline dyestuffs, and now there are eighty engaged in this business. In addition to this, many concerns that are now producing explosives, will in time of peace, convert their works into dye plants. Seventy-five per cent of the dyes we use are now being manufactured in this country, and they are being produced in quality fully equal to the German product.

At the outbreak of the war we suddenly found ourselves in an indigo famine. Our own stocks were soon used up, and then we began to use up the surplus stock in China, where large quantities had been imported for use in all parts of that vast country. When it was found that a big price could be obtained for the dye, the Chinese were only too glad to trade their indigo for American gold. But the Chinese stock is now practically exhausted. In the meantime, however, American manufacturers have undertaken the production of this dye; one concern is now turning it out at the rate of a ton a day, and will be in position to continue to manufacture it after the war, in the face of German competition.

But not only in the coal tar industries have we made remarkable strides; we have invaded various other fields in which Germany predominated. It was thought, at one time, that optical glass and glass for use in chemical industries could only be made at Jena. Efforts to compete with the German product were unsuccessful prior to the war, mainly because of a natural suspicion of substitutes. Manufacturers were not willing to try the American product as long as they could get the well-tried material that they were accustomed to using. Now, they have been forced to try American glass, and have found it to be fully the equal, and in many cases, superior to the imported product. For instance, the German chemical glass had to be made very thin so as to withstand temperature changes. In this country we have developed a glass which can be made comparatively thick and yet withstand the same temperature changes. In fact, this thick glass has come to be used for cooking purposes, baking dishes, etc.

Another development of the war has been directed to the recovery of waste. One of the exhibitors at the recent show demonstrated a method of recovering a valuable product from the sulphite waste of paper mills. This disagreeable black stuff that has heretofore poured out of the mills discoloring the streams and killing all fish life, is now put through a machine which extracts the water and recovers the solids in the form of a very fine, brownish powder, rich in resinous material, and very sticky. This has a value now of $40.00 per ton and is used as a filler for leathers and in glue manufacture.

The chemical awakening of the United States due to the cutting off of German imports, has been one of the most remarkable outcomes of the present war. We have reached a position of independence which might not have been attained for generations. Our chemical engineers are still forging ahead with every prospect of placing this country at the very head of chemical progress.

Naval and Military

Quick Repair of German Steamships.—It is very gratifying to learn that the attempt of the German Government to wreck the fine merchant ships of the German lines which were interned in American ports, by destroying their machinery has been foiled. Thanks to the resourcefulness and energy of our shipyards, both Naval and private, these ships will be available as transports for our troops to Europe as soon as the troops with their artillery and supplies are ready to sail. For some weeks the American flag has been flying on the "Vaterland"—the world's largest ship, and those two fliers, the 23-knot "Kaiser Wilhelm II" and "Cecilie," will shortly be in service.

A Winter of Training.—The War Department chose wisely in locating the majority of the training camps for our drafted National Army in the South; for they have decided not to send these troops to France until they have been toughened up and trained by several months of experience under simulated war conditions. The southern camps will benefit by the warmer temperatures and absence of snow, as compared with the winter conditions in the northern states. The War Department is justified in its determination not to send our drafted army into the trenches until it is in absolutely first-class shape. In this decision it has been guided by the dearly-purchased experience of our Allies during the early years of the war.

Vast Destroyer Programs.—Conditions in the present war are changing so rapidly that naval policy has to be very alert and elastic. Secretary Daniels has shown that he is keeping in close touch with developments; and the latest evidence of this is his adoption and earnest support of the proposal to build a large destroyer fleet, additional to the one we already possess. He recommends the expenditure of $350,000,000 for the construction of destroyers and the erection of new yards or the enlargement of existing yards to provide additional facilities for building these most useful craft. Plans have been prepared for a standardized type, and, if the appropriation asked for is granted, it should be possible to lay down from 250 to 300 destroyers within the year. The boats we have sent to the other side have done excellent work.

Magnitude in Modern War.—The magnitude of the war, as a whole, is repeated in every phase of its activity, and in no way more so than in its instruments of war. As we have more than once remarked in these columns, it has been necessary to multiply our units of measurement by from 10 to 100. Weapons which were thought massive and powerful in 1914 are puny in 1917. Thus, heavy artillery, whose weight tied it down to fixed fortification, is now moving merrily over the field of battle. Where, formerly, we talked in millions, now we talk freely in billions. Before the war 25 to 30 knots was battle-cruiser speed—today we have such ships of from 150,000 to 200,000 horse-power steaming at 35 to 40 knots. A notable instance of this growth is in the field of aviation, where the British have aeroplanes of 600 horse-power and the Italians have gone up to 1,000. And the end is not yet.

Decline in U-boat Sinkings.—Whatever may be the cause of the great drop in the losses of ships due to the U-boat, it cannot be denied that the low figure of only eight ships sunk of over 1,600 tons in the twenty-ninth week of unrestricted submarine warfare, is very encouraging. We do not know whether this result is due to a more vigorous anti-U-boat campaign and the use of new and more effective methods, or to the sinking of U-boats and a let-up in submarine activity. Probably both causes have been at work. For reasons best known to themselves, the Germans do not seem to be building submarines at the rate which was expected; but it is quite possible that they are constructing a new fleet of much larger boats, carrying guns of 5.9 caliber, and designed to operate on extended cruises far out in the Atlantic. If so, we may look for a rise in the rate of losses as soon as the submarines of this new type are commissioned and sent to sea in numbers.

British Standardized Ships.—The first of the standardized merchant ships built to order for the British Government recently went through successful trials of a very exhaustive character. The type has been designed to provide a good cargo-carrier, in the shortest time, and with the least expenditure of material. The keel of this trial ship was laid last February, and in less than six months the ship was completed, loaded and ready for trial. The standardized vessels, which are of 8,000 tons capacity, are built in two types—one a single-deck for grain and the other a two-deck ship for general cargo. It is also intended to build two similar types, each of 5,000 and 3,000 tons carrying capacity. Not only the hulls but the engines are standardized. They have extra large hatchways to facilitate quick loading and discharging—a most important feature. The first vessel was built in five months' time, and it is expected that future vessels will be turned out in from four to four-and-one-half months.

Aeronautical

Work at Our Training Camps.—The aviation Section of the Signal Corps of the U. S. Army authorizes publication of the following information pertaining to progress at the flying camps: Five hundred and thirty-nine flights were made at the Mineola school during the week of July 21st, totaling 222 hours 12 minutes. During July 14th, 586 flights, totalling 265 hours 34 minutes, were made at the San Diego, Cal. school. At Camp Kelly, San Antonio, Tex., 85 flights were made during the week of July 28th, for a total of 48 hours and 17 minutes.

The Part of the Naval Air Service.—That aerial activities are not confined to land operations is proved by the recent announcement from Paris, to the effect that during June last French seaplanes carried out 3,139 flights; attacked German submarines on 10 occasions; discovered in six cases enemy minefields; and took part in nine night bombardments on enemy bases. They also carried out some reconnaissances at a considerable distance from their base. During the same period French naval airships made 141 trips, representing a total of 483 hours in the air.

America's First Captive Balloon in Service.—On April 22d the first American captive observation balloon to be manned by a civilian crew, went into active training service on Staten Island. The operatives are members of the Columbia University Volunteer Signal Corps, and they are being directed in their work by Major Carl F. Hartman of the United States Army, who has had experience in this class of training. The balloon is an 80-foot sausage type, and was purchased largely through the efforts of Mrs. Charles A. Van Rensselaer, under whose direction $10,000 was raised for this and other expenses of the unit.

A Mid-Air Charge.—One of the first cases of direct, deliberate ramming of one aircraft by another was seen a few days ago behind the German lines, says Mr. W. Beach Thomas in a recent despatch to the *Daily Mail*. A British and a German machine charged each other direct from a considerable distance. The German, who must have been a very stout fellow, kept a perfect bee-line to the very end, apparently seeking mutual destruction. The British pilot turned at the very last moment, and so rammed not the center, but the right wing of the opposing craft, which he carried away, and the German plane fell in a heap to the ground. The British machine was very badly damaged, but was still just airworthy, and the engines carried it in a wobbling declivity safe into harbor.

Italian Aeroplane Mail Service.—A firm of Turin, Italy, intends shortly to inaugurate an aero transport service between that city and Rome, according to U. S. Consular advices. Permission has been accorded by the Italian Minister of Posts and Telegraphs for the carrying of mail between the two cities and the surrounding sections, and until special stamps have been issued by the government the ordinary "express" or "special delivery" stamp of 5 cents is to be used, with note made on the envelope that the letter is to be sent by aeroplane. No stamp other than the "special delivery" is required, but the using of this stamp for this particular services does not imply the delivery of the letter by special messenger to destination, as would ordinarily be the case. Special letter boxes are to be placed in the post offices and railway stations in both Rome and Turin wherein letters for the aero post may be deposited.

Three Years of Aerial Fighting.—Worthily following the lead set by misleading statistics published by the German Main Headquarters, the *Berliner Tageblatt* has collated some figures which purport to compare German and Allied losses in the three years of war. With the warning that exact details up to the end of February, 1915, and for July, 1917, are not yet forthcoming, so that the figures for these periods are not "absolutely trustworthy," it gives the following table:

Period	Germany	Enemy
1914	...	9
1915	91	131
1916	221	784
1917	370	1,374

From August 1st, 1914, to July 31st, 1915, 72 enemy aeroplanes were shot down, of which 39 fell into German hands; from August 1st, 1915, to July 31st, 1916, 455 enemy aeroplanes were shot down, of which 267 fell into German hands; from August 1st, 1916, to July 31st, 1917, "about" 1,771 enemy aeroplanes were shot down, of which 776 fell into German hands. In 1915 two enemy captive balloons, so far as is known, were shot down; in 1916, 42; in 1917 to August 1st, 142. Three enemy airships were also shot down. Total aircraft shot down from August 1st, 1914, to August 1st, 1917, about 2,298 enemy and 682 German aeroplanes, 186 enemy captive balloons and three airships! Surely, as long as such statistics are prepared for German consumption it is simple to understand why the German masses entertain high hopes of emerging victorious from this war.

Automobile

Auto and Aero Engines.—Many improvements in automobile engines have been brought out in recent years but the progress in aeroplane engines puts them entirely in the shade and suggests the inquiry what the automobile engineer has been doing with his time. The new ideas will be applied to the land vehicle later, but it looks like inertia among the automobile makers.

Pure Air for the Carbureter.—Although it has been well known for years that a considerable proportion of the deposits that form in the cylinder head is composed of grit and road dust, which is highly injurious to the entire interior mechanism of the engine, remarkably few efforts have been made to overcome the difficulty, and to conserve the motor by cleaning the air before it is admitted to the carbureter. This is an important point that should receive more careful attention.

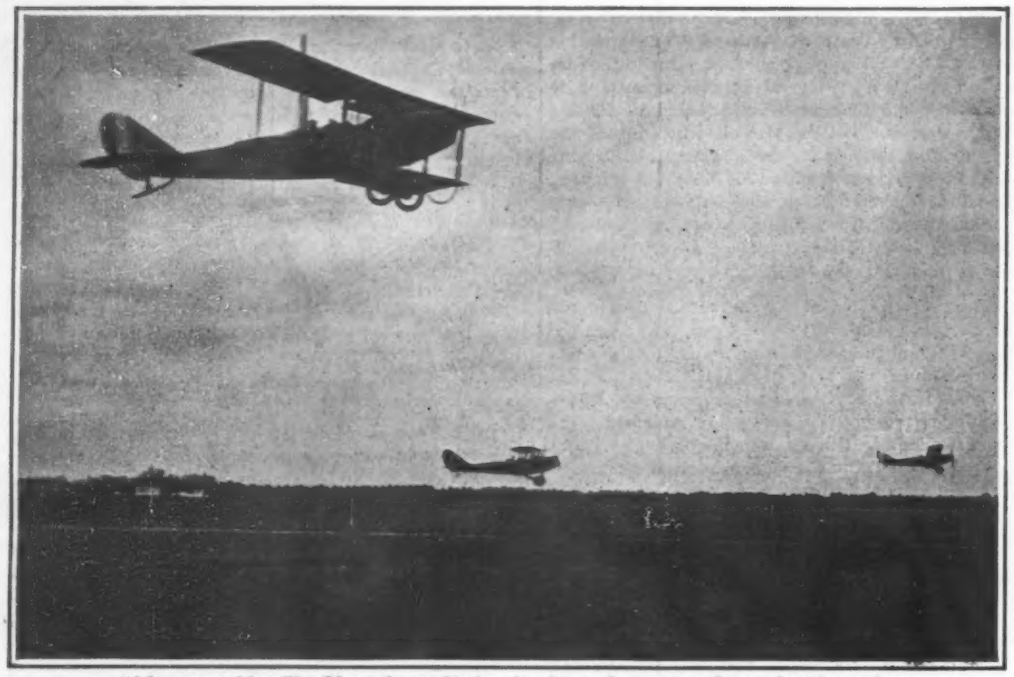
Jack Troubles.—In an interesting article in *The Automobile* on defects in design, as revealed by observations of cars in the Italian war service, the writer calls attention to the fact that no provision is made for placing the jack, in many cases there being no place for the jack other than a bolt head. Furthermore, he says that frequently a jack that will go under the front axle is too low for the rear axle. He suggests that the manufacturer design his car to take a jack and supply a jack to fit the car.

Illuminating Gas for Fuel.—Owing to the scarcity of gasoline some car users in England are making a trial of illuminating gas. An instance of this is a motor "chars-a-banc," which corresponds to our long, public passenger car, which makes the trip from Eastbourne to London, a distance of about sixty miles. On the roof of the car is located a large rubber bag, about five feet high when inflated, and the size of the roof, which is said to hold 400 to 500 cubic feet of gas. This bag is charged six times during the trip, so that one filling only carries the car about ten miles. The owners say they find a considerable difference in the amount of power developed from the various gases.

Accessibility.—An important point for prospective buyers to look out for when selecting an automobile is the accessibility of its various parts for adjustment and repair. When it is necessary to remove the entire body to enable a single loose bolt to be tightened, or the engine to make a simple adjustment, the repair bill on what should be but a five-minute job is decidedly discouraging, not to speak of the loss of time. These examples may be rather extreme, but the fact remains that accessibility is often made a secondary consideration by designers. That this should be so is difficult to understand, for good will is an important asset in these days of keen competition, and no amount of fancy accessories and free extras can off-set heavy repair bills.

The Cut-Out to be Abolished.—One of the most sensible things that has occurred in the automobile world for many a day is the decision of the National Automobile Chamber of Commerce to abandon the practice of fitting cars with muffler cut-outs; and it now remains to be seen if the manufacturers generally will live up to this decision. The cut-out has been an unmitigated nuisance for years, but just because it constituted a "talking point" it has been retained, to the disgust of the saner portion of the community. It has been demonstrated that a properly designed muffler absorbs but an insignificant fraction of the power developed—much less than is required to haul around the flashy, but unnecessary "accessories" seen on many cars, so there is no good reason for retaining the cut-out on that ground; and it is certainly superfluous in any thickly settled community. No one is more ready to say harsh things about a noisy motorcyclist than the automobile owner, and yet the great majority of automobile drivers are guilty of the very same offense, and with far less excuse.

Motor Fuels and the War.—Transportation facilities are among the most important problems of the war, for no army could exist without adequate and prompt supplies; and the same matter is almost equally important at home. Motor vehicles are among the most widely used agencies for this work, and their supplies of fuel are therefore vitally important; but while most other commodities are being made subject to supervision and conservation nothing has apparently been done to control and regulate the use and the price of gasoline. If there is any truth in a report of an English oil company the gasoline business of this country merits strong government control. The report in question states that "Oil is actually being taken today from San Francisco to Calcutta by tank steamers and is being sold there at a price which is lower than that which is realized for the same oil in San Francisco itself. To prove to you how useless is this competition, I may mention that we actually hold 30,000,000 gallons of petrol ready for shipment at our Eastern refineries. No one in this country needs any instruction from me to realize what it would mean if this could be brought here by the tonnage which is being so wantonly wasted."



"After something like fifteen hours in the air with an instructor, the student is ready to fly alone, or 'solo'"

"They are obliged to take down an engine completely and reassemble it . . . . "

With the American Airmen of Tomorrow

A Day Spent at an Aviation Training School "Somewhere in New York State'

By Austin C. Lescarboura

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HAD it not been for a battered but nevertheless efficient touring car conspicuously labelled "Aviation Field," I should have been obliged to walk some two miles along a road none too cheerful. As it was, I was soon bowling along toward the flying school, after leaving the train that brought me out from New York in somewhat less than an hour.

This jitney, operating between the railroad station and the field, was significant to me. The mere fact that it was waiting at the depot signified that there was considerable traffic between there and the flying field. Years ago, when aviation was in its infancy in this country, I spent many a Sunday wandering about the flying fields in this vicinity. In those days the improvised aerodrome was lined with a few shanties that served as hangars for the experimental machines in building and undergoing tests. Many a mechanically-inclined man was to be seen hard at work on an aeroplane of his own design, spending all his spare time and money in what he thought a highly profitable venture. The machines which these pioneers were constructing were queer contraptions: there were monstrous aeroplanes of unknown breed; heliocopters which were designed to pull themselves up by means of horizontal propellers; and omnicopters with bird-like flapping wings. Equally queer were the engines, many of which had lived and had passed away in automobile service.

Sunday was usually the big day or field day, when the products of local conception and construction were carefully wheeled out on the flying grounds for a tryout. Hours would be spent by the mechanics in tuning the engines and truing the planes; and the machines were groomed with that care only accorded the finest of racing horses. Then came the time for the test flight, when there was practically no wind and the weather conditions were next to ideal; for in those days flying was a fair weather sport, at least for these machines.

As the aspiring aviator would climb into his machine the spectators would surge forward so as better to see what promised to be a real flight. After much coaxing, nursing, and threats, the usually balky engine would start up with a roar; and at the command of the airman the machine would slowly make its way over the field, rolling on a none too smooth terrain. Now the airman would tilt his elevating planes—and the machine would continue along the ground in the same lumbering way. Try as he would, the airman could not make his machine leave the ground. Crude, under-powered engines, poorly designed machines and insufficient wing surface were generally the cause of the aeroplane preferring to live the life of a grass mower rather than that of an artificial bird. Indeed, this was a blessing in disguise; for many of the crude contraptions of those days would have collapsed in the air if they had ever been able to get off the good old earth.

All these reminiscences flashed through my mind as we rolled along toward the new field. Suddenly a speedy tractor biplane with a shiny yellow body and a bright tricolor tail, passed over the road but a short distance ahead of us, and, turning its nose at a sharp angle, dived behind a high green fence of the Army aviation school, which we were now approaching. This pretty scene served to lay aside all thought of the past: I was prepared for the new era of aviation in this historical vicinity.

A Beehive of Human Activity

After satisfying the sentry at the entrance that I had been granted permission to visit the field, I was brought before the adjutant and given a pass. Leaving headquarters I strode down the main street to the office of the lieutenant whose guest I was to be for the remainder of the day. Here, indeed, was a busy thoroughfare, lined with substantial buildings for housing the men, the mess, the local Y. M. C. A., the canteen, and other characteristic institutions of our military camps. This community fairly swarmed with khaki-clad individuals and civilian mechanics in their overalls. Motor trucks, automobiles and motorcycles incessantly dashed by, manned by khaki-clad men. Here and there I could pick out the aviator of tomorrow, not so much by what he wore, but by his bearing. For there is something about an aviator that makes it a simple matter to pick him out from among a group of other men. Despite the fact that these aviators were wearing the plain service shirt, they stood out unmistakably from the little groups of infantrymen and enlisted mechanics.

"They are taught how to scrape bearings and how to aline the crankshaft . . . . because it is important that they should know whether these repairs are properly made by their mechanics"

My lieutenant friend happens to be the technical instructor at the flying school, and his office is in the repair shop building. So I found him hard at work on an aviation engine in more or less dismantled form, performing a delicate operation in the presence of a number of keenly interested students. I watched him explain the function of every part, even down to the smallest spring, and its relation with the other parts. He emphasized the importance of keeping the engine in perfect condition, for, as he expressed it, "A faulty engine at the front means that you are apt to land behind the enemy lines and be made prisoner, or come down sufficiently close to enemy troops to be shot down."

Our future airmen are given a thorough course in shop work as part of their training. They are obliged to take down an engine completely and reassemble it, so that they become familiar with every part and the function of that part. They are taught how to scrape bearings and how to aline the crank shaft, not so much because they will ever be asked to make these repairs and adjustments, but because it is imperative that they should know whether these repairs are properly made by their mechanics. And the sagacity of this training is evident; for during a flight everything depends on the engine, to quote the lieutenant instructor.

General repairing is also part of the American airman's training. In the woodworking shop he is taught how to make the thousand-and-one repairs on the standard Curtiss tractor which is used at this field, with the result that he is sure to know as much about the work as the average aeroplane mechanic. Thus the finished airman from this school is in a position to oversee any work being done on his machines, guide the mechanics, and check up their work. He is able to detect any flaw in the workmanship and materials. And he is accordingly in a better position to safeguard his life from the unseen dangers.

The Mechanic as a Life Saver

Right here we come to the subject of aeroplane inspection. At this flying school they pride themselves in the thoroughness with which each machine is inspected at frequent intervals, and the care with which all repairs are promptly made. Each machine is under the direct supervision of a field inspector, whose duty is to see that it is kept in first-class condition. He is provided with a printed form known as the "Weekly Airplane Inspection Card," which must be filled out and turned over to the Chief Inspector. This form calls for information on the condition of the propeller, gasoline system, water system, engine, wing joints, wing wire, landing gear, oil system, fuselage nose, wing fittings, ailerons, rudder,

alinement of entire machine, struts, stabilizer, vertical fin, elevators, rail, skid, fuselage rear interior, and the controls. That the information must be detailed is evident from the fact that each of these classifications is subdivided; so that the one on the propeller, for instance, calls for data on the condition of blades, hub assembly (bolts, washers, cotters), security of shaft, and thrust. Each field inspector signs the weekly inspection card for his aeroplane: he is held personally responsible should any accident occur through faulty inspection.

Repairs are promptly made; for at this field there are ample facilities for machine work and woodwork of all kinds. And there is always a sufficient number of machines in flying condition to accommodate the aviator students, no matter how many may be in the workshops.

What our careful system of inspection and repairs means is perhaps best expressed by what I heard in the course of a conversation with some of the men. A French lieutenant, who was stationed at the school, is reported to have been very much impressed with our thoroughness, and compared it to the rather hurried inspection and infrequent repairs which most of the French school machines receive. It is not an uncommon occurrence for several students to be killed in one week at some French flying schools, he said, owing to insufficient inspection and neglected repairs.

Carrying out our policy of "safety first" to the utmost extent, every machine arriving at the field directly from the manufacturer is carefully unpacked and assembled by the personnel of the school. I saw one aeroplane after another arriving on those powerful, dusty, five-ton, Army motor trucks, packed up in long, narrow cases which overhung for at least one-third their length beyond the motor-truck body. These cases were unloaded into empty steel hangars by dozens of jolly soldiers, later to be assembled by the students and mechanics. In another hangar I saw the latest type of Curtiss training machine in process of erection. The beautiful woodwork, carefully-made wings and body with their glossy coat of varnish, and the business-like, silvery engine impressed me with the high quality of workmanship of our aircraft constructors, reports to the contrary notwithstanding. The machine was supported on wooden horses, and in all directions stretched out the steel guy wires which were to be fastened in place and then tightened up until the whole structure was trued and made rigid. This work, I was told, required the utmost care, and its execution was excellent practice for the student aviators who would someday in the near future supervise the reassembling and truing up of machines shipped to France in knocked-down form.

Hatching Out Our Airmen

It was about three o'clock in the afternoon when I was told to stand near a row of new steel hangars at the northern end of the field if I wished to see the inspection of the machines by the commanding officer and his staff. By this time a considerable number of machines were lined up facing the hangars, each "toeing" the line and with its covered propeller in a vertical position. Here and there a mechanic was tightening a guy wire or turning a bolt on the engine or in one way or another grooming his machine for the inspection. The machines, being all of the same type, presented an inspiring sight as one stood at the head of the line and gazed down toward the last machine.

By chance, I happened to glance toward the main group of buildings on the western fringe of the field, and discerned a group of soldiers walking toward the line-up of aeroplanes. A few moments later the commanding officer, accompanied by two aides, arrived at the head of the line, and upon receiving word that everything was in readiness the little group proceeded slowly down the row, inspecting each machine in turn. Once or twice they paused, and spoke a few words to the mechanics standing in front of a machine. Evidently they were issuing helpful suggestions or instructions; for right here let me say that this inspection is certainly anything else but a mere formality. Indeed, the commanding officer and his hatless aides were dressed in plain service shirts, and it was only by the golden oak leaves of the former and the silver bars of the latter that they could be told apart from the student aviators. Little wonder that our French allies were so much impressed with the democratic appearance of our first troops to march through Paris!

Following the inspection, things began to hum. Here and there an aeroplane was turned about so as to face the field. Students, fully dressed in leather jacket and padded head gear, began to arrive in ever-increasing numbers. They climbed into their machines, in some instances alone and in others with their instructor. Mechanics got busy cranking propellers, and soon a half dozen engines were droning in almost perfect rhythm. One aeroplane with its engine turning over slowly, rolled away across the field at a speed not much in excess of a brisk walk. It lumbered along with an up-and-down motion, much like a small ship at sea. It turned toward the east, then toward the north and finally toward the west whence came a strong breeze; whereupon the pilot speeded up the engine and after a short spurt the aeroplane gracefully left the ground, climbing steadily into the heavens. Meanwhile another aeroplane and still another moved out over the field, seemingly feeling their

"He is able to detect any flaw in the workmanship and materials, and he is in a better position to safeguard his life from the unseen dangers"

way like some giant insect, and then taking to the air. Then a few more left, until I counted six machines flying over the aerodrome.

This rolling over the ground is known as "taxi-ing" at the school, and the rules are very strict in this connection. The students are obliged first to "taxi" across the field, trying out their engines all the while; and when everything is found satisfactory they can break away from the grass-covered field. In "taxi-ing" each aviator must see to it that a good headway is maintained between his machine and the one in front of it, and this and many other similar regulations make for a complete absence of dangerous collisions.

The dual-control method of instruction is used at this school. The student is taken up from the very beginning in a training machine equipped with a dual set of controls. The student sits in the front cockpit and the instructor in the rear. After the student gets the "feel" of the air he is allowed to handle the controls with which he has already familiarized himself. Little by little he learns how to steer and how to climb or descend, and how to maintain the lateral stability of the machine. The ever-watchful instructor rectifies any mistakes the student may make with his own set of controls. After something like fifteen hours in the air with an instructor, the student is ready to fly alone, or "solo." And after five hours in the air doing "solos," the student can usually qualify for his Reserve Military Aviator certificate.

During the remainder of the afternoon I saw nothing but aeroplanes in the sky. The machines would invariably "taxi" over the field, manouver into a position facing the wind, and then go up into the skies. All airmen circled over the grounds and landed at the northern end of the field, only to start all over again.

"We lay particular emphasis on starting and landing in our course," I was informed by an obliging instructor. "If there is one thing the men learn here," he continued, "it is how to land. Most training schools the world over do not pay enough attention to landing. And as a result the men never learn how to land properly. Doubtless you will admit that landing is one of the most important things in flying."

I heartily agreed with him. As he spoke I watched the student-airmen landing in front of the green hangars, with a nicety that suggested a huge feather drifting gently to the ground. Cruising over the hangars each aeroplane, with propeller barely turning, came down steeply toward the field, only to flatten out a few feet above the ground, and then floated down until the wheels lightly touched the grass. With hardly a bump the aeroplanes came to a halt.

Truly, our airmen of tomorrow know how to land.

Loop-the-loops, nose dives, tail spins, side slides and other elements of tactical flying are not encouraged or even countenanced at this flying field. The men are only permitted to make plain flights. When they have proved, by obtaining their certificates, that they know how to fly, they will be sent to other schools for a "finishing-off," which will include trick flying, aerial machine-gun practice, bombing, and so on. Later, we shall establish advanced aviation schools here in America; but for the time being the urgency of our preparations calls for plain fliers to be sent to other schools for advanced training. Even so, an airman graduating from an American flying school is more or less familiar with everything pertaining to military aviation, because of theoretical training at the "ground school" and theoretical and practical training at the Army school.

On my way back to the railroad station I passed the old flying field. Again there came back to me the visions of former days. I could picture in my mind the old hangars and the crude machines on the flying field, with the handful of interested spectators. "What if we had been more interested in aviation then?" I thought. "What if hundreds or even thousands of persons had visited that flying field?" Well, for one thing we would have been ready to send thousands of airmen to the other side at the very beginning of our war with Germany. Again, we would have the latest types of fighting machines ready for service.

While waiting for the train I saw a biplane cross the tracks about a mile away. My thoughts flashed back to the Army school—to the new order of things in American aviation—which to my way of thinking betokens that whatever may have been our handicap at the outbreak of this war, we assuredly are fast preparing a personnel and a materiél worthy of a great nation.

Blowpipe Method for Breaking Metals

A PROCESS for producing a quick and clean break upon steel bars has been recently invented in France by M. Bellanger. A steel bar is submitted, at one or several points around the line where it is to be broken, to the action of an oxydizing flame from a blowpipe or in other cases a reducing or neutral flame, the bar being placed upon two supports at the proper distance apart. In this position the bar receives a stroke from a knife edge tool applied in any suitable way, or a pressure can also be employed, and this causes the bar to break off sharp at the determined point. The effect of the flame at the treated point is to produce a modification in the structure of the metal analogous to that obtained by the tempering process, and the metal loses its elasticity and becomes brittle, but this takes place only in a narrow limit around the metal, leaving the rest as before. Under the effect of shocks or pressure, the metal breaks at this weak point, and is claimed to give a very clean as well as rapid break. M. Bellanger's process bids fair to become universally adopted.

"Repairs are promptly made; for at this field there are ample facilities for machine work and woodwork of all kinds"

A Three Years' Flying Experience

What the War Has Done for Aviation as Viewed by a Pioneer Airman

By Capt. B. C. Hucks, R.F.C.

Paper Read Before the Aeronautical Society of Great Britain

THE past three years, although normally a short space of time, yet measured by the advance of aviation, has been a veritable lifetime. Many thousands of people are now deeply engrossed in the subject. Most of you who have honored me with your presence here to-night have studied flying from the very highly technical and scientific side, in fact far too technical and scientific for me, and you certainly know a great deal more about the subject from that point of view than I do. I hope that this plain, non-technical account of things, hardly touching upon the war, connected with my flying which have been brought to my notice during these three years, may interest you a little and perhaps form the basis of a discussion.

I think I am right in saying that through the war aviation has advanced more than it would have done in eight or ten years of peace conditions. In fact, the rate of improvement in aircraft is so fast, the pace so alarmingly rapid, that it is almost impossible for manufacturers to keep pace, for it seems that by the time the latest and most efficient type of machine is manufactured in sufficiently large numbers to gratify half the requirements of the services, that type is out of date and obsolete.

Progress Owing to the War

That you may realize at a glance the remarkable strides that have been made over this period I will show you some diagrams which, without giving any figures that may be military secrets, should convey a fair idea how the capabilities of air-craft have improved. I have taken the average performances of five different types of service machines used at the beginning of the war and compared them with the average performances of five different types of late patterns now in use in France.

The first diagram represented the growth in three years of the maximum speed capacity flying level. The second diagram consisted of two curves showing the increase in machines' capacity for climbing against time. The next diagram represented the growth of horse-power developed by aero engines. And lastly, the increase in the number of certified pilots during the past three years.

A pilot has only to take a short flight on a 1914 type machine and then fly the latest 1917 pattern as a comparison to really appreciate this colossal advance.

Some little time ago I had occasion to again fly, after a considerable lapse of time, a 50 horse-power Gnome Blériot, a one-time premier machine, in fact a type used quite a lot by ourselves and the French at the very beginning of the war. At first I believed the machine to be a very bad specimen of the species, but ultimately after flying it for some time and acquiring a sort of lost art of balance, like a skater who has not skated on ice for years and has to get his legs again, I realized that it was quite a good specimen of the type, but that it takes quite a time to again get used to such inefficiency. The advance seems to have been along, one might say, quite conventional lines, that is, improvements on what might be accepted as standard designs, and no good results have been obtained from any departure from that standard. Perhaps the furthermost departure from what I call standard, and that is very slight, has been the triplane. The results obtained with the quadriplane have not justified the experiment.

The Inherently Stable Machine

During the past three years the first marked improvement, to my mind, which asserted itself was the inherently stable machine, attained apparently by such slight detail alterations as sections of planes and elevators that it required an experienced eye to detect a stable or unstable airplane by casual inspection when standing together. Then came the synchronized timing gun-gear, which enabled the machine guns to be fired through the propeller or tractor machines. This device is really so simple that one is at a loss to understand why it had remained so long undiscovered. It had the effect of giving the tractor type of machine a new lease of life; although a more efficient one aerodynamically than the pusher, it had been falling into disfavor as a fighter on account of the inability of the pilot to shoot straight ahead of the machine.

Improvements in engines, to my mind, are responsible for present-day performances to a far greater extent than improvements in machines, chiefly through sheer increase of horse-power. And cases have occurred where certain obsolete types have been made serviceable simply by fitting an improved type of engine.

The improvements in the machines themselves seem to have been limited to details, such as wing sections,

attention to head resistance, soundness of construction, etc.

The very efficient freak machine has yet to make its appearance.

I will not attempt to discuss the future of aviation, but setting aside the boundless commercial possibilities, I am more and more convinced that if we find it necessary to keep up an enormous navy, say a two-Power standard, to protect our island, it will be essential to maintain at least the same standard in the air. That in itself guarantees a colossal future for aeronautics.

But to return to the subject of my paper to-night, I would like to place before you a few points as I have found them during a further three years of pilotiug.

Difference in Machines

I have flown many different types of airplanes, and considering the extraordinary variations in the types the difference in the actual piloting of any modern machine, to my mind, is remarkably small. I am of the opinion that a pilot who is thoroughly efficient with any particular type will in a very short time be master of any other.

I find that on stepping out of a very fast small scout into a really big twin-engine machine the difference in the manner of piloting is very slight compared with the vast difference in the machines. Precisely the same methods are employed, the same trouble and risks are to be avoided; the chief characteristics seem to be that the smaller and faster machines are more difficult to land but are easier to handle in the air. In the case of "crashes," the larger and heavier the airplane the less damage is likely to occur to the occupants, as a tremendous amount of the impact is absorbed by the machine. Very much larger and heavier machines than those at present in use might be comfortably flown single-handed, no extra effort being required for the controls, provided the controlling surfaces are properly balanced.

To the lay mind it might appear that with such contrasts in the outward appearance of the smaller and larger machines, it would be necessary to train pilots specially and extensively for each type, but in my experience this is not so. I certainly think the best results are obtained when pilots are allowed to specialize. This, however, I understand has many drawbacks on active service.

Crashes are mainly due to three causes, viz., engine failure, faulty piloting, and faulty machines.

Engine Failure

Engine failure undoubtedly is responsible for most of the crashes, often because of the hopeless unsuitability of the landing ground at the pilot's disposal. To many pilots engine failure is most disconcerting, and it is then they are called upon to use rather more judgment and skill, so that even with a fairly suitable landing ground available they very often crash. In my experience, embracing the testing of hundreds of new machines, it is seldom that a serious defect in the engine "lets one down," it is nearly always due to a small detail. I think I have had to make more forced landings through failure of the petrol supply than all the other troubles combined. This is due more often to failure of the pressure feed than to a choke in the supply pipes and very seldom to severed connections in the feed system.

Because of the absence of a float chamber to the carburetor in the rotary engine, even a variation of the gasoline pressure is more serious than in the rigid stationary type. In the former case the amount of gasoline that gets to the engine is controlled by the pressure and a fine adjustment. If the pressure increases unduly, the engine chokes from over-richness of mixture; on the other hand, if the pressure drops away the mixture is unduly weakened. This variation can be controlled by the fine adjustment to a large extent; but when that limit is exceeded the engine will fail. Most of the trouble seems to be caused by failure of the pump, which in some cases forms an integral part of and is driven by the engine; in others it is a separate unit, driven by a small airscrew. These failures are usually through valves sticking up and pistons becoming dry. Other causes of failure are in the relief valve not being pressure tight or sticking down. At any rate the present system of pressure feed, to my mind, is such a bugbear that it is high time something was substituted.

As far as the non-rotary engine is concerned, to my knowledge this matter is being tackled. I have been flying recently a machine fitted with a gasoline pump in place of the air pressure pump, the gasoline being pumped direct from the main tank to the carburetors and the surplus is returned to the tank through an adjustable spring-loaded relief valve, so that gasoline is delivered at any desired pressure to the engine. So far it has proved most satisfactory, with this advantage, that a punctured tank does not put it out of action. Dirt in the gasoline tank accounts for quite a large proportion of engine failures in new machines. This form of trouble ought to be avoided. It is an important matter which manufacturers should be made to recognize, and a very thorough system of tank washing employed before installation in the machines.

The dirt in the tank usually takes some time to work its way into and accumulate in the feed pipes or filters sufficiently to choke them. The machines are often by that time being delivered under their own power by pilots who are none too familiar with them, consequently engine failure means a good chance of crashing.

I remember having four forced landings while delivering a new B.E.2.C from Farnborough to Dover on this account. Another simple cause of engine failure which might easily be guarded against is that gasoline cocks in many cases have no definite locking device to insure that they remain in the open position during flight, consequently they are liable to vibrate into the "off" position, thus cutting off suddenly the gasoline supply. Many instances have come to my notice where gasoline cocks are fitted in such a manner that the tendency is, through the weight of the cock lever, to fall shut instead of the reverse. This is such a simple and yet such an important point that it really is surprising mistakes like this are continually allowed to be made. I have had engines cut out suddenly on three occasions during the past two months from this cause alone; one meant a forced landing because the gasoline cock was not accessible to the pilot, the other two were opened again in the air. It often leads to serious results, as the gasoline fails suddenly and it is seldom that the cause is discovered before the forced landing is made. Having a somewhat limited time at my disposal this evening I will not touch on what I have found to be other causes of engine failures, but I can assure you that as far as my experience shows they are a small proportion compared with those due to gasoline supply, and improvements in this direction will reduce engine failures enormously.

Faulty Piloting

Errors of judgment or faulty piloting account for nearly or perhaps as many crashes as engine failure.

The most common error made even by experienced pilots is losing flying speed on a turn which starts a side-slip, and given sufficient height terminates in a nose dive, or the more serious predicament, a spin. This mistake is often made under the stress of circumstances, when engine failure calls forth extra effort on the part of the pilot to reach a certain landing spot. The trouble is nearly always incurred by turning too flatly until the wing drops and the machine side-slips, generally in the effort to get into more suitable ground than that available straight ahead. This is always a dangerous maneuver, and in nine cases out of ten when smashes have resulted probably less damage would have been caused had the pilot kept his machine from turning and pancaked straight ahead. I have found that most of the later type machines can be stalled (*i.e.*, speed reduced well below flying speed) without any risk of side-slipping, provided they are kept in a straight course and laterally level, as they will automatically drop the nose as soon as the speed becomes so low that the elevators have little or no effect. Most of the serious accidents start at

(*Concluded on page 260*)

Strategic Moves of the War, September 27th, 1917

By Our Military Expert

FOR some days the duel of heavy guns on the Flanders front from the coast to Lens and beyond presaged important movements which the Germans could not fully locate. Having lost their initiative, they are in constant fear of attacks that may fall at any point; they are also unable to prevent them or to repel them. The gun fire had been the most continuous and intense that had been known and as this was aided by aerial operations on a vast scale that led to the bombarding of aerodromes, munition depots and even of bodies of German troops at long distances behind their front lines, the undoubted supremacy of the Allies both in artillery and in air strength that was shown in the spring drives was again established beyond question.

Finally, on September 19th, the British commander made his attack on an eight-mile front east of Ypres, that swept over the German lines for a mile or more capturing many prisoners and important German positions. The Germans undoubtedly knew that an attack was coming but they were unable to establish the exact locality until the British offensive had really begun. Fighting of the most vigorous kind took place over the entire front; but the British troops could not be driven back and all the points of vantage that were marked out to be taken were carried by storm. What was most marked was the relatively rapid advance of the infantry, preceded by five distinct barrages of artillery fire; the magnificent artillery preparation made the different stages of the advance much easier, especially as the preceding drum fire for a number of days had swept the ground in many places like a broom, leveling earth works, barbed wire and concrete redoubts, and silencing many batteries. It is said to have been the most terrible barrage fire the war has yet produced.

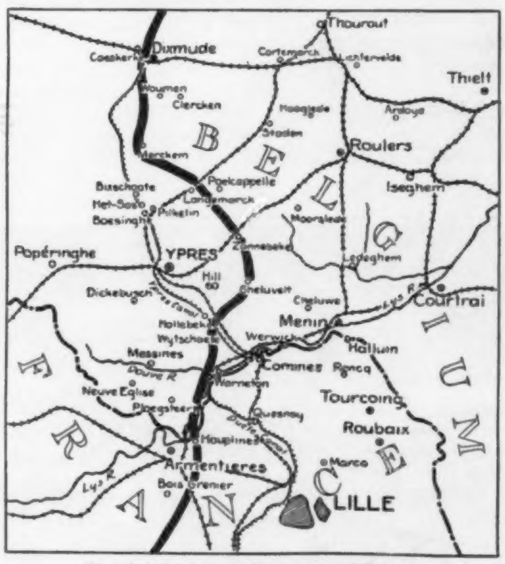
Since the first advance there have been constant attack and counter attacks; but, as a whole, the British troops have held their gains and have consolidated their positions—all of which means that their lines have been reestablished, their artillery brought up to new positions, and everything made ready for one more "nibble" such as is constantly practiced. Whether the advance will be in the direction of Menin to flank and cut off Lille and to lead to its abandonment or whether it will be towards Roulers and Thourout in the direction of the coast has not yet developed. In either case a break in the German lines along the present offensive must entail the loss of the Belgian coast to Ostend and beyond and a retreat of the German lines beyond the Scheldt. The drive so far has been as much in the direction of Menin, the key to Lille, as in the other direction toward Roulers. The capture of Menin would put a curve around Lille similar to that around Noyon, Péronne, Bapaume and Croiselles which led to the retreat of Hindenburg's armies.

The advance toward Roulers would be the easier because the country is flat, there are no large streams to cross and the town is only seven miles away, giving relatively easy access in the direction of Bruges and outflanking Ostend. In this portion of the front, the best German defence would be to open the canal sluices and to flood the country, which is flat and below sea level. That this seems to be in contemplation is shown by recent information from German sources that the civil population of Roulers, Thourout and Courtrai has been ordered to leave. If the country is not flooded, then a general retreat of the Germans seems to be the only course open to them.

Heretofore, the German commanders have taken little heed of the loss of men; and this view continues, for their losses in the recent counter-attacks must have been enormous. As their columns advanced, the British guns have torn them to pieces and have driven back in retreat those who survived the artillery fire. All observers testify to the marked deterioration in the fighting qualities of the German troops on the present front as compared with the forces first on these lines. No one can deny the persistent dogged courage and determination with which they fight but the élan of former days is now lacking; officers and men seem no longer to look forward with any hope of success on the western front and talk constantly of peace. On the contrary, the spirit of the Allies, particularly of the British, is at the highest pitch; they are filled with the idea of their superiority over their opponents and the determination to fight out the war.

The progress on all parts of the western front is slow and, to the onlooker at a distance, some of the operations appear to have little lasting effects on the desired results —but such a view is entirely erroneous. The outsider considers progress only when he hears of an important position or town as being captured, or a successful drive of several miles forward through the lines with numbers of prisoners and guns taken. He loses sight entirely of the great, the inestimable value of the slow grinding process that wears out the enemy's nerves and stamina in addition to causing losses in casualties. There is a constant drain upon the Germans, not only of men but of war supplies that are expended and also destroyed by British gun or shell fire. The German defense is still strong—of this there can be no question—but, as stated above, it is weaker than it was and sooner or later the constant attrition must wear it down.

An illustration that has been taken from a newspaper account will show what losses occur even when there has been no marked fighting in a great battle. It is stated that thirty-five German divisions, which should total about twenty-five thousand men each, were on the Flanders front about six weeks in July and August. Eight are still there but nineteen have been withdrawn for rest and reorganization and eight have been transferred to parts of the line where there is less continuous fighting. The average time spent in the front trenches by a German division is eight days, when the casualties become so great it has to be withdrawn. In this connection it is said that in the battle of the Somme a year ago, thirty-four German divisions were employed of which twenty-two were withdrawn on account of casualties after twelve days of fighting. During the fighting around Verdun in August ten German divisions were withdrawn after fighting two days as a minimum to four days as a maximum. The casualties in eight of these divisions were so great they were regarded as exhausted.



The British operations around Ypres

There is another phase of war losses that can be well considered in addition to actual casualties in killed and maimed—viz.—the economic loss to Germany after the war from deaths in battle. It has been computed that in the past three years she has lost more than a third of her able-bodied men. Another year, 50 per cent of her available able-bodied man power would have disappeared, while it is estimated that England, her great commercial rival, would have lost only 25 per cent. This percentage would be greatly reduced by considering England's man power in the colonies, estimated at two and one-half million white males. Germany has lost her colonies which have been taken by her foes; she has lost her world markets in all countries, particularly in those of her enemies. She will therefore face the world in a position very different from the one that was hers before the world war began, especially when the position of the United States is considered. So far in the war, Germany by using her prisoners and the populations of the occupied districts for work behind the lines, has been enabled to put an unusually large percentage of her male population upon the firing line. She has thus been enabled to hold out but she has vastly increased her losses among her able-bodied males, which losses will be most severely felt when her industries attempt to revive after the war and when she finds how large a proportion of her wealth-producing population has gone from her. It is then and then only that the full measure of her defeat will be appreciated by her people; it is then too that her political troubles and struggles will begin in full force.

But little of interest has recently occurred on the Gorizian front though there have been violent concentrations of artillery fire and repeated counter attacks by the Austrians on the Bainsizza Plateau against the lines recently wrested from them by the Italians; this is also true of the vicinity of Monte San Gabriele recently captured. As all these positions guard the deep ravines of the Chiaprovano valley along which advances in the direction of Laibach can be made, their importance can be readily understood. The plateau of Ternova is really an extension of the Bainsizza Plateau, from which it is separated by the Chiaprovano valley; if Monte San Daniele and this plateau can be taken, the plateau of the Carso will be flanked and, once in Italian hands, the road to Trieste will be opened. The present desperate Austrian defense can therefore be thoroughly understood; no doubt Germany is giving such aid as she can, for the fall of Trieste would be a grievous blow to her Mittel-Europa dream. But on the other hand, France and Great Britain are contributing all they can to Italy's wants; for she has lacked not man-power, of which she has an abundance, but guns and munitions. Here, as on the western front, the expenditure of munitions has necessarily been enormous. As Italy must import all her coal and ores, her allies must and probably will satisfy her demands as far as they can, for they realize now the ability of the Italian commander as a great organizer, tactician and strategist.

The truth of Napoleon's remark that the entrance to the back door of Germany lay via Laibach to Vienna was never more evident than at the present time—a suggestion that the Italians are evidently bearing in mind in their attempted advances on this front.

Italy has at present also in Albania a large army, said to number 500,000 men, probably organizing to move eastward upon the right flank of the Austro-German-Bulgarian army. The presence of this force not only guards the flank of the British-French forces in Macedonia but enables supplies to be brought overland through Italy to and across the Strait of Otranto, thus avoiding the dangers of a Mediterranean passage.

On the Riga front German pressure has caused the evacuation of Jacobstadt and 25 miles of lines on the west bank of the Dwina River. Unless the Russians can defend the river crossing, the Germans, once over the stream, can move in force on Dvinsk, which must share the fate of Riga. So far, however, this has not happened and recent accounts speak of Russian successes between Riga and Venden north of the Dwina; certainly the Germans have not advanced far beyond Riga after its capture. It would seem that they are not now in a position to spare the men for any serious invasion of Russian territory.

Just now there remain only five or six weeks of fighting weather and after that, except for minor operations, the winter hibernation on all fronts must begin. It is therefore, well to look back over the year with a view to grasping what can be expected in 1918. What has taken place in 1917 can be soon told; as regards the present war, it has not been distinguished by any marked battles as has been the case heretofore. The collapse of Russia changed entirely the Allies' plans; and Germany had none, as she has been altogether on the defensive. The revolution in Russia has put off the great blow from all sides that had been prepared by the Allies; but this has been deferred only till 1918 when our own troops in numbers great enough to be effective shall have arrived on the scene.

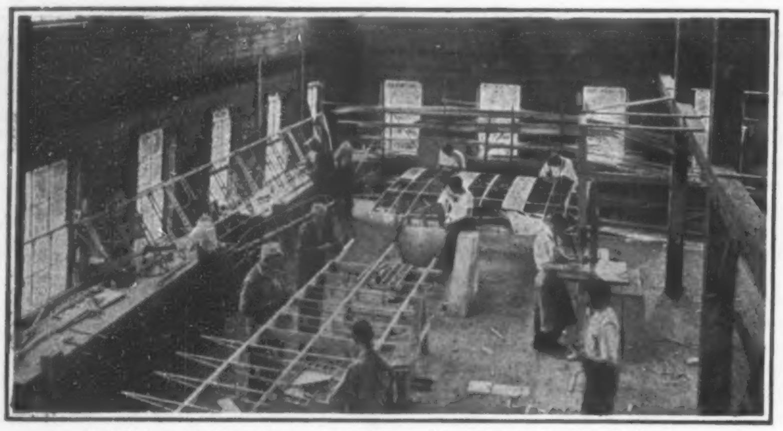
When the Aerial Cavalry Charges

SOME months ago an intrepid young airman, perceiving a column of German infantry advancing to the relief of their sorely tried brothers-in-arms in the front line trenches, swooped down from the skies and, when a few hundred feet above them, poured a deadly machine-gun fire into the dense ranks. Taken by surprise the German soldiers were unable to defend themselves; they either hesitated and were shot down, or fled to the nearest shelter.

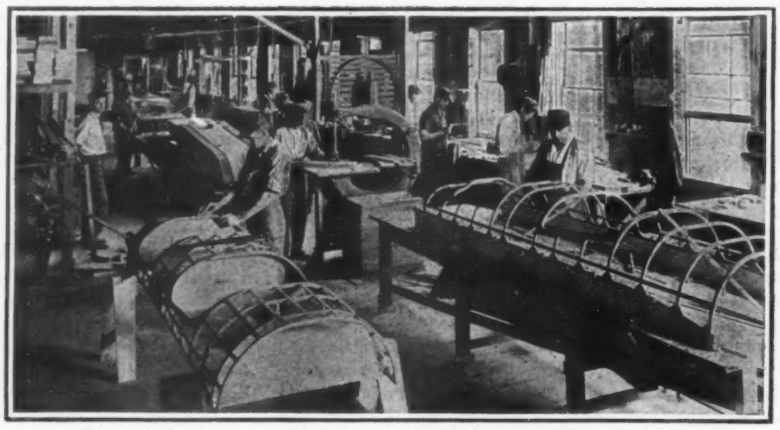
What was merely intended as an incident of a reconnaissance trip over the lines proved to be the forerunner of an organized attempt on the part of airmen to cooperate with infantry as a sort of aerial cavalry. Indeed, during the last Ypres offensive of the British at least 28,000 rounds of cartridges were fired by the Allied airmen into the German ranks, and it is said that at least a score of "hornets" participated in that battle. While the aerial cavalry "sat" on the German trenches and rear positions, pouring streams of lead into the German troops already preoccupied with the attacks of British infantrymen, all the while laboring under a veritable tornado of high explosive and steel, many more machines of the single-seater type mounted guard high above, ready to engage in battle with any German aircraft that might dare to attack the troublesome "hornets."

For this class of service the aeroplanes employed must be of the fastest types obtainable, for their defence against enemy fire is entirely in their speed and maneuvering ability. They must be of the single-seater model, armed with a single, fixed machine gun firing through the propeller. The heavier and better armed machines, which are necessarily slower, are absolutely worthless for this service. During an attack on infantry the airman must come down to within 300, 200 or even 100 feet of his target, dash along with his machine gun sputtering away at full capacity, and then sweep up again into the skies.

And the aerial cavalry, it appears, has come to stay.



Skilled cabinet-makers at work on the wings of an aeroplane, assembling the ribs and transverse girders



These frail structures, when covered with linen, are to form the top of the aeroplane fuselage

Aeroplanes in the Making

Work for the Cabinet-Maker, Mechanic, Needleworker and Painter

Photographs Copyrighted by Brown & Dawson

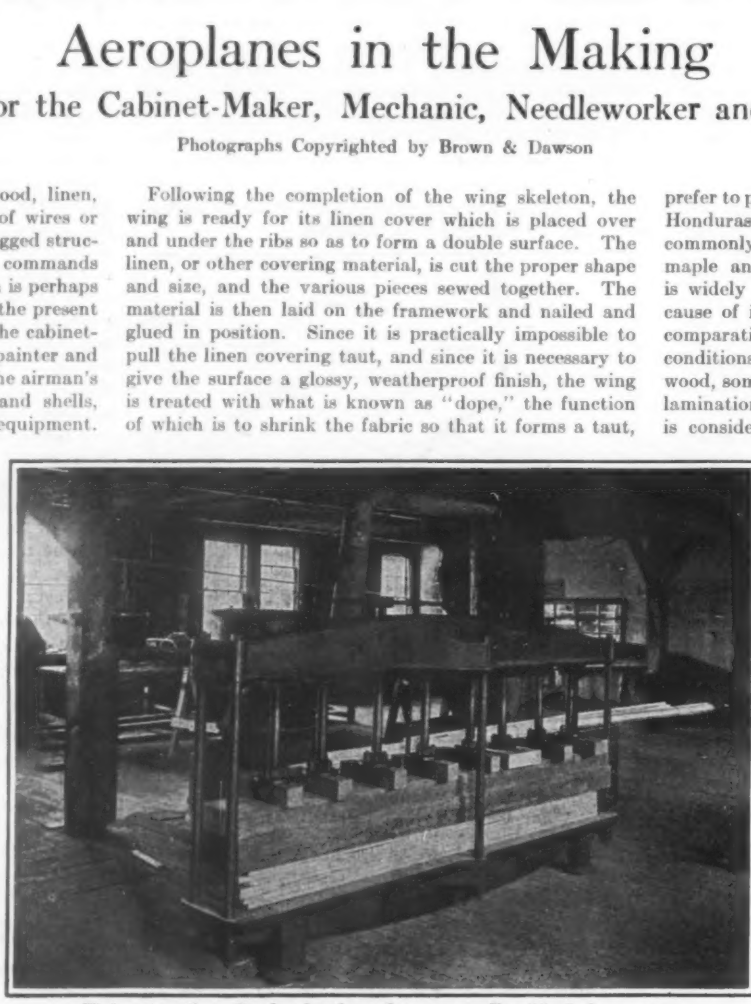
BUILT of such frail materials as light wood, linen, glue, and varnish, so braced by means of wires or cables as to form the rigid and remarkably rugged structure which we know, the aeroplane of today commands a certain fascination in its manufacture which is perhaps not shared by any of the other machinery of the present war. Indeed, it calls for the best efforts of the cabinet-maker, the mechanic, the needleworker, the painter and other artisans; for after all is said and done the airman's greatest danger is not the hostile bullets and shells, but the hidden, unsuspected flaw in his own equipment.

In the main the aeroplane consists of a fine piece of carpentry. The body is made up of numerous pieces of wood, cut, trimmed and sandpapered to the proper shape and size. For joining the various wooden members metal fittings are used, and this practice results in a stronger and more business-like product. In fact, it is the increasing use of such fixtures which has marked the development of the aircraft industry; and the tendency is more and more toward the extensive use of all manner of metal fittings. After the assembly of an aeroplane member, the structure is braced and trued by means of wire stays, which are carefully adjusted by skilled workmen.

The more delicate woodwork is to be found in the manufacture of the wings and control surfaces, such as rudder, elevator and ailerons. These are built up of a number of rib members, each of which consists of a filler piece and two strips. The filler piece, is strongly suggestive of a thin slice of Swiss cheese, being sawed out at intervals to leave a thin framework which gives support and shape to the thin strips tacked to it. Transverse beams serve to support the ribs, and the various components are assembled, glued, nailed and screwed together to form the wing, which is then trued and braced by guy wires.

Far from being a haphazard piece of work, each rib is made after carefully prepared designs. And it is largely upon the accuracy with which the woodworker follows the designer's plans with regard to each rib, that the success of the finished aeroplane depends. Rib shapes are based upon the results of experiments in aerodynamic laboratories, and this phase of aeroplane design is accordingly today a matter of accepted formula.

Following the completion of the wing skeleton, the wing is ready for its linen cover which is placed over and under the ribs so as to form a double surface. The linen, or other covering material, is cut the proper shape and size, and the various pieces sewed together. The material is then laid on the framework and nailed and glued in position. Since it is practically impossible to pull the linen covering taut, and since it is necessary to give the surface a glossy, weatherproof finish, the wing is treated with what is known as "dope," the function of which is to shrink the fabric so that it forms a taut,



Gluing together the laminations for a propeller block in a press which exerts from one to two tons pressure

smooth covering. If the wings are to be used for a United States service aeroplane, they are stenciled with the seal of our aerial forces. This consists of a blue field with a white star, in the center of which is a red ball. The usual practice in large aircraft plants is to stencil the colors, after which a painter carefully goes over the design and perfects it with an ordinary painter's brush.

The manufacture of aeroplane propellers is an art in itself. Many concerns are engaged in propeller construction exclusively, and aircraft constructors, as a rule, prefer to purchase their propellers rather than make them. Honduras mahogany, birch and whitewood are most commonly used in propellers, with ash, gum, spruce, maple and poplar as occasional alternatives. Spruce is widely used with engines up to 50 horse-power, because of its light weight, strength, ease of gluing, and comparative freedom from changes caused by climatic conditions. Engines of greater power call for other wood, sometimes in combination—for instance, alternate laminations of maple and spruce. Quartered white oak is considered a fortunate choice for engines of exceptional power, while for extreme climatic conditions, such as service in the tropics, Honduras mahogany, only moderately strong and therefore eliminated under normal circumstances, is selected because it is least affected by extremes of temperature and humidity.

Seasoning is an important factor in propeller manufacture. Wood should preferably be air-seasoned for a period of about five years; but the propeller constructor has difficulty in procuring wood even two years old. To some extent this is overcome by treating the stock which comes from the lumber yards. The wood is placed in a dry kiln and gradually heated to about 140 degrees. Steam is then introduced into the kiln, causing the pores of the wood to open up and in this manner releasing the impurities. Such treatment is continued for a period of several days, sometimes as long as two weeks, after which the wood is allowed to dry.

Dressed down to the proper thickness —a propeller is made up of a number of thicknesses or laminations—the individual boards are treated with glue and piled up, sometimes into a shape roughly that of the finished propeller, sometimes into a plain block. They are then placed in a press while the glue sets. A pressure of one to two tons, depending upon the hardness of the wood used, is applied to a block measuring 10 feet long by 12 inches wide.

Using the block as the material in the rough, machine and workmen get busy with their carving operations. Slowly, but surely, the rough block is whittled into shape. Sometimes special propeller-shaping machines

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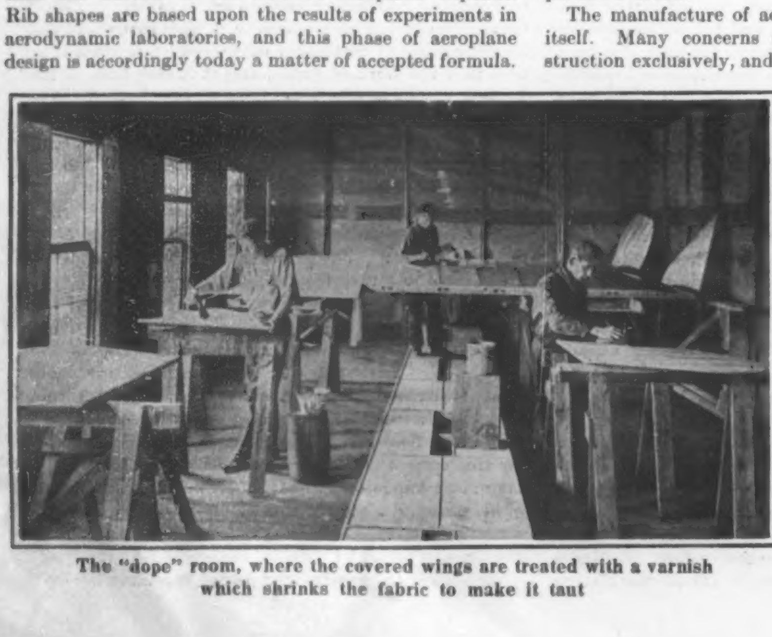
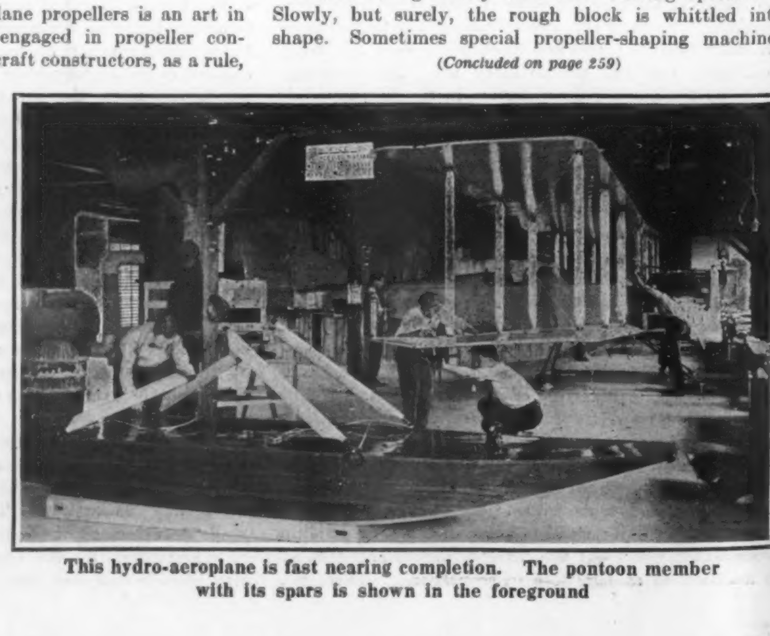


The "dope" room, where the covered wings are treated with a varnish which shrinks the fabric to make it taut

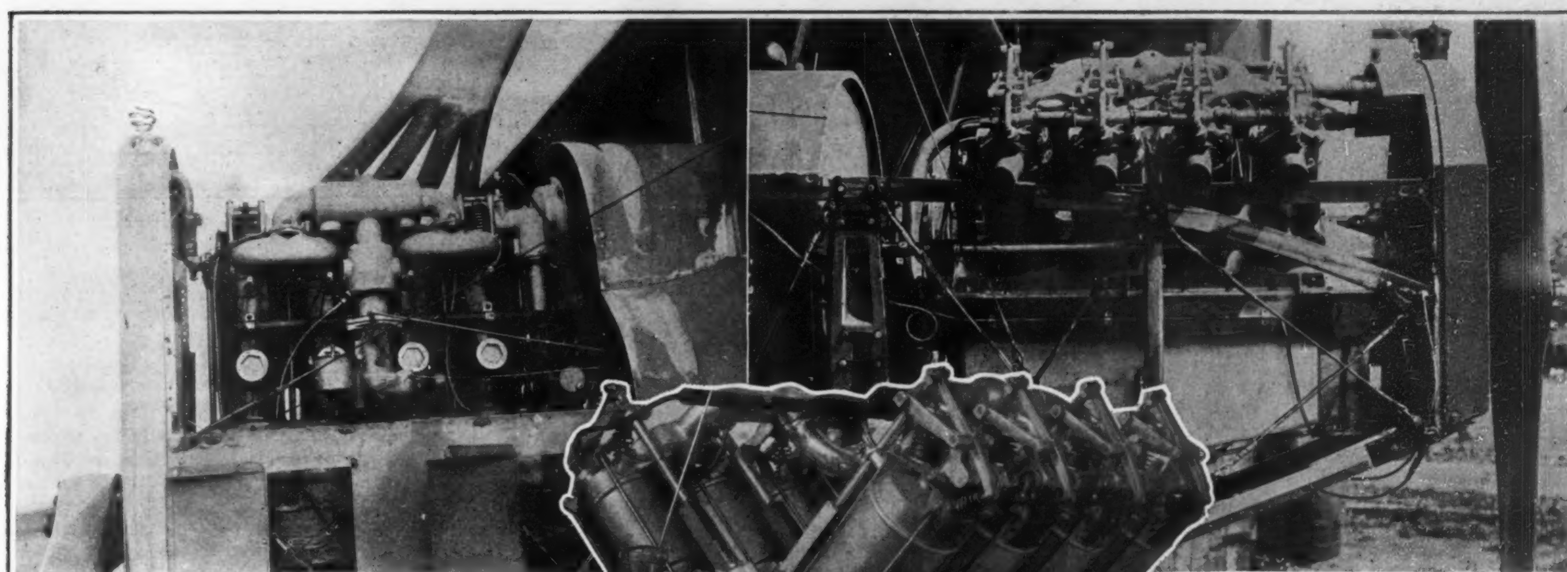


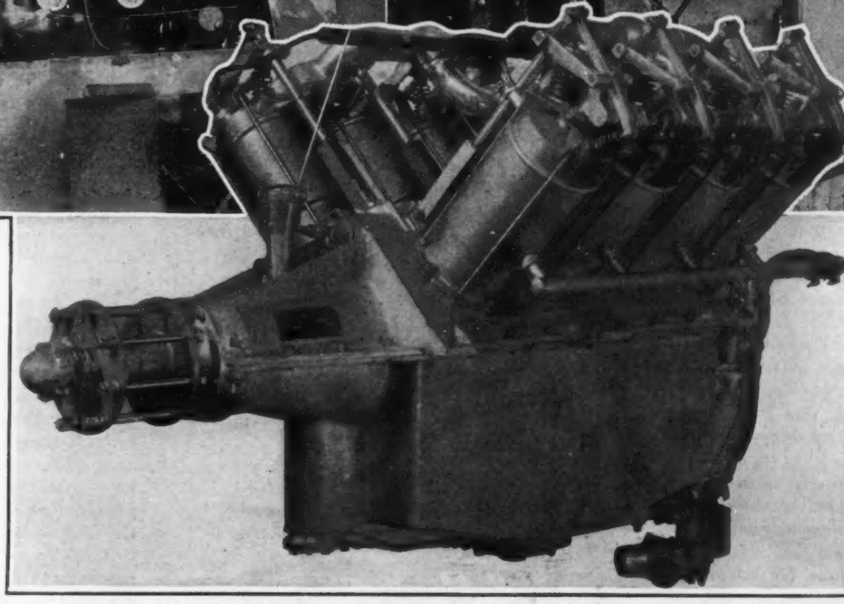
This hydro-aeroplane is fast nearing completion. The pontoon member with its spars is shown in the foreground

Development of Aviation Engines

Interesting Facts Concerning the Aeroplane's Main Member—the Power Plant

By Lieut. Victor W. Pagè, A.S.S.C., U.S.R.





At the left: A Hall-Scott 90 horse-power four-cylinder engine installed in aeroplane fuselage. *At the right:* The installation of the Curtiss OX2 engine in the fuselage of a Curtiss JN4 training biplane. This power plant is one of the most popular American designs and is an eight-cylinder V-form rated at 90 horse-power. *Below:* The Curtiss OX5 100 horse-power engine; an eight-cylinder model incorporating several novel features such as the compact valve-actuating mechanism in which concentric push rods and pull rods are used to open the valves in the cylinder head.

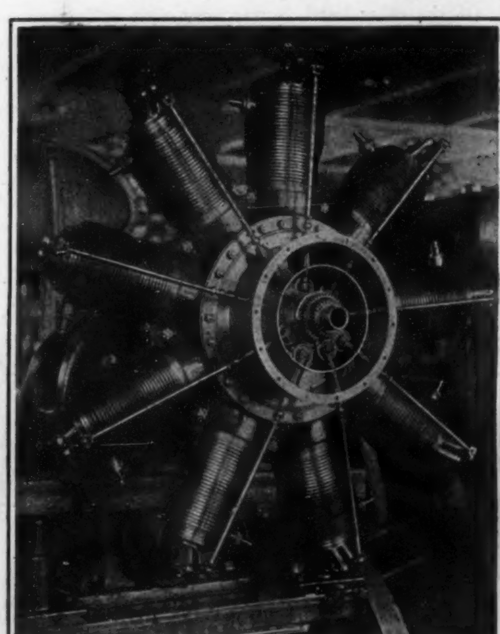
Stationary types of American aviation engines now in use

THE reader who is not thoroughly conversant with the great improvement that has been made in motor car engines, will have difficulty in appreciating how the great capacity per unit of mass of the light motors designed especially for aerial work is largely possible through experience gained in the automobile engineering field. When aeroplanes were first devised numerous unconventional forms of internal combustion engines were contrived that were believed to have features making them specially suitable for the propulsion of aircraft. These included many radial cylinder or star shaped motors, others having a fanwise disposition of the cylinders and still another type in which the crankshaft was fixed and the radially disposed cylinders revolved around it. Of these forms, practically the only type to have survived is the rotating cylinder engines of the Gnome, LeRhone, and Clerget patterns, and by far the greater number of aircraft are provided with engines of the vertical cylinder type and with eight- and twelve-cylinder engines of the V-form, both of which constructions have thoroughly proved their worth in motor car service.

The Battle of the Light-Weight Engine

The development of extremely light-weight motors that possess reasonable endurance has been made possible because of a thorough knowledge of the best proportions of engine parts and the use of special metals of high tensile strength, which those engaged in the automobile industry possessed. Activity in the development of light motors has been much more pronounced since the start of the present world-war than at any other period because it is only since the outbreak of hostilities that the great importance of the aeroplane has been recognized by the military authorities. The development of light motors has been carried on in all of the warring countries, though each group of belligerents has worked on somewhat different lines. The Germans have concentrated their efforts on vertical cylinder motors of the Benz and Mercedes types and have seldom used engines having more than six cylinders. The Allies, on the other hand, have experimented with numerous types of engines, and aeroplanes are now in service which have power plants with from two to as high as twenty-four cylinders. The rotary form which has been developed in France is a popular type for certain work, but for the most part the engines contrived are of the eight- or twelve-cylinder V-form. Some of the aerial motors have been really complicated types made light by the skillful proportioning of parts and the use of the best and most expensive materials of construction, such as chrome nickel and chrome vanadium steels; others are refined, simpler forms, modified from current automobile and racing-engine practice. Indeed, the most successful engines may be considered as following conventional engineering rather than "freak" design, the only noticeable departure from this rule being in the rotary cylinder forms.

At a time when the aeroplane construction programs of all the warring nations call for a material speeding-up in production it will be evident that the tendency to depart from the freakish or unconventional construction and to adhere more closely to standard forms will mean the production of duplicate engines in large numbers, that will have every quality making for reliability, efficiency



An American-built rotary type of engine, which weighs three pounds to the horse-power.

and endurance. The most popular form of aeroplane engines are those having six or more cylinders, and while machines have been flown with engines of the two- and three-cylinder forms, these are seldom used at the present time except as "penguins," which are special machines for primary instruction intended only to roll on the ground and teach a beginner the manipulation of essential controls. Training machines have been built having engines of the four-cylinder type, but the development in aircraft design has been so rapid that the modern successful plane requires engines of three and four times the power that was considered ample before the outbreak of the present war. Owing to the limitations of design, large aeroplanes have been equipped with a multiplicity of motors so that some large machines developed have four power plants which in the aggregate produce from 1,200 to 1,500 horse-power. Even the small, high-speed scouts or battling planes, which were formerly considered amply powered with an 80-horse-power engine, are now equipped with power plants capable of giving 150 and 200 horse-power.

The weight of the engines of recent development has been reduced to such a point that it is now possible to obtain complete power plants which will not weigh more than three pounds per actual horse-power, and while these are air-cooled, revolving-cylinder types, it has been possible to build water-cooled engines of great endurance which will not weigh more than four pounds per horse-power. In some of the very high speed scouting machines which operate at altitudes above 20,000 feet and which are capable of attaining speeds ranging from 125 to 146 miles per hour, it has been found necessary to use engines of more than 300 horse-power on the ground in order to compensate for the inevitable loss in power at high altitudes.

Before the war, if a plane was provided with one horse-power for about every twenty pounds weight it was considered capable enough for use over the battle lines. At the present time aeroplanes having this ratio of weight to horse-power are used only for instruction purposes at primary training flying fields because they are much too slow and do not have the climbing ability that is required in modern warfare. The fast scouts may have one horse-power for every eight or ten pounds weight, and in some cases of recent development the proportion has been even lower than this. If we consider briefly the requirements of the aviator it will be evident that the most important is securing maximum power output with minimum mass and at the same time it is desirable to conserve as many of the good qualities existing in standard automobile motors as possible. These are reliability and certainty of operation, reasonable endurance, good mechanical balance, and uniform delivery of power. All of these are fundamental conditions which must be obtained before a power plant can be considered really practical. In addition, there are secondary considerations which, if not absolutely essential, are none the less desirable. Among these are minimum consumption of fuel and lubricating oil, which is really a factor of some import; for upon the economy depends the capacity and flying radius of a plane. This is of especial value in the motors intended for reconnoitering or bombing planes, as one equipped with an econom-

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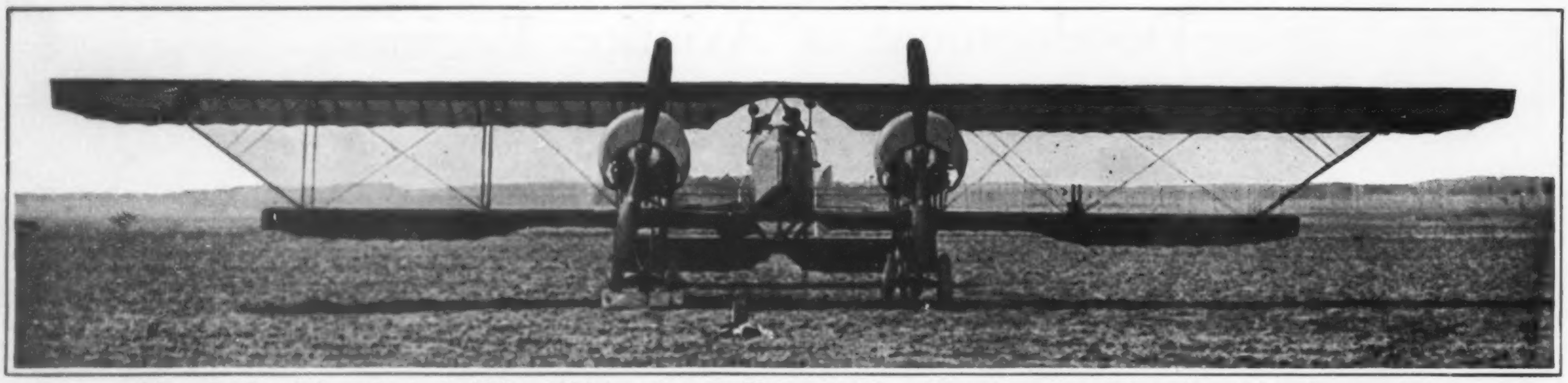


A huge Caudron, twin-engine tractor biplane which is used on the Western front for artillery observation, photography, and bombing operations

The Classification of Military Aeroplanes

Why Various Types of Heavier-than-Air Craft are Employed in Military Aviation

By Bertram W. Williams

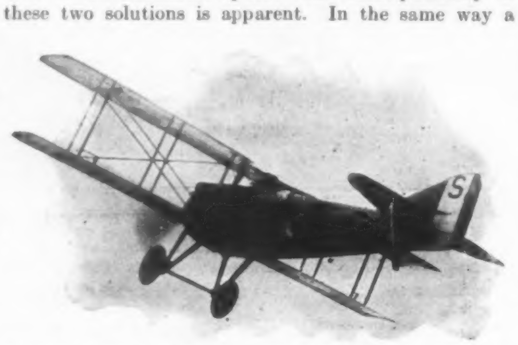
THERE has been a strong propaganda in the press lately urging on Congress the necessity of building up a large aerial force with which to defeat Germany. Although the idea is commendable, yet, unfortunately, there is little likelihood of its immediate realization. An aerial navy and its personnel cannot be built and trained in a few months; and the mastery of the air is hardly likely to come so easily to the country that regarded aviation with apathy for years while other nations took it seriously. The governments of France and Germany, and of England to a lesser degree, have since 1911 been doing all they could to encourage the output and use of aircraft; and if those three nations are at present pre-eminent in the air, their supremacy has not been gained without the loss of many lives and much experimentation.

The few aeroplane manufacturers in this country deserve all the credit and fortune that probably awaits them, but it is scarcely to be expected that they will be able to compete immediately with European factories in such a scientific business as the making of modern warplanes. French and British experts who have lately visited this country give it as their opinion that a large output of strongly-built machines suitable for school work will do more to aid the Allies' cause than an attempt to turn out the more delicate and complicated fighting and reconnaissance craft which require years of experience and aerodynamical knowledge to build.

The average American, when he takes the least interest in the matter, has a very hazy idea of flying machines. To him they are all "airships"—a name which in Europe is applied solely to lighter-than-air dirigibles. At the most he will divide them into two classes, monoplanes and biplanes, with a vague idea that the former are the faster, and the latter the more stable craft. As a matter of fact there are almost as many recognized types of aeroplanes as there are makes of automobiles, each being distinct in its appearance and characteristics from the other.

It is, of course, impossible to give details of the latest fighting machines on the battle fronts. Their construction is—until one falls into the enemy's hands—kept a zealously guarded secret. But, just as all navies have their battleships, cruisers, destroyers and submarines, so aeroplanes may be classified into four groups, each having its separate function of usefulness. Constructors first thought of building an almost unique type of aeroplane which would serve for all uses of war. The advantages of this unification were obvious: greater facility of production, of repair, and of apprenticeship. Unfortunately it was a Utopian idea, and had to be abandoned. Just as it is impossible to have one single type of ship, and it has been found necessary to create different types for different needs requiring specific qualities of armament, tonnage, speed and defence, so it has been found necessary to create different types of aeroplanes.

Certain of the functions required, demand, in fact, qualities which not only differ but are opposed to each other. Thus, the ideal apparatus for regulating artillery fire would be one capable of perfect immobility above the points to be observed. A "chaser," on the contrary, calls for the greatest possible speed. Now, in aviation, the lowest speed without falling is always in relation to the greatest speed—it is roughly equivalent to 50 per cent of the maximum speed. The incompatibility of these two solutions is apparent. In the same way a "bomb-dropper" must above all be a weight lifter, a quality entailing considerable wing surface, and consequently low speed and a certain difficulty in maneuvering.



A typical battleplane in flight: The Spad "biplane de chasse."

On the other hand, it was impossible to increase to infinity the types of machines, because there was neither an infinity of models nor of motors, and the qualities of an aeroplane are first of all determined by the power and weight of its motor. A compromise was therefore arrived at by the selection of four principal types of aeroplanes, which are, according to their uses: (1) scouting aeroplanes; (2) artillery observation aeroplanes; (3) bomb-droppers; (4) battleplanes. Each of these types is divided into sub-types, ranging from what may be called the minimum of utilization to the maximum of utilization.

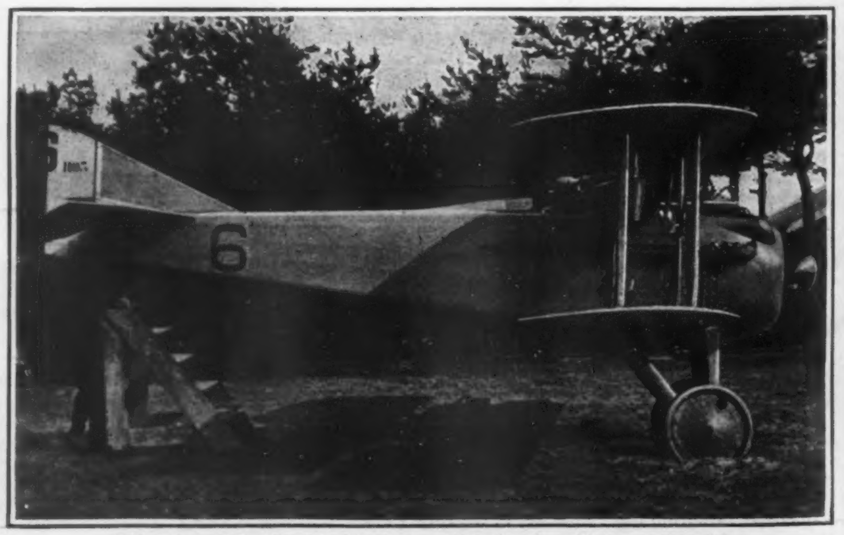
Regarding the first type—the scouting aeroplane—it may be pointed out that the trench warfare of modern times has considerably reduced the range of action necessary for a scout, whose object is to examine the enemy's lines first by eye and afterwards by means of photography, and that, therefore, no great quantity of fuel has to be carried. The principal qualities desirable in a scout are maneuvering facility and climbing power, so as to enable it to escape from enemy chasers, as it is almost impossible to protect them by convoys of fighting aeroplanes owing to the irregularity of their missions. Their equipment generally includes a camera, a machine gun for defensive purposes, and a wireless installation. On the French front these are generally Farman machines, stable and fairly capable of maneuvering. Their great size, however, makes them an easy target for anti-aircraft guns. The Farman has a large gliding angle, a feature of great importance, as should anything happen to the motor when over the enemy's lines, it is possible to *vol plané* back to the zone of safety provided the machine is at a reasonable height.

Artillery observation aeroplanes, or "spotters," are generally two-seaters, not necessarily fast, but with great climbing powers, that is, they must be able to ascend quickly to a safe altitude. It is also of extreme importance that they should provide a good view for the observer. For this reason they are often of the "pusher" type having the propeller behind, an arrangement which gives the crew a greater vision, although it interferes to a certain extent with the speed and stability of the machine.

As regards bomb-dropping aircraft, their chief value lies in their capacity for weight carrying. This can sometimes be dearly bought at the expense of speed and radius of action. It is, therefore, generally found more advisable when it is desired to carry large quantities of bombs, to distribute them among a number of machines.

The fourth type is the battleplane or chaser—*appareils de chasse* the French call it. Contrary to what one might expect, this is not a large, heavily-armed machine, but a light, speedy single-seater of comparatively small wing-spread. In aerial warfare one first of all attempts to make use of one's own aeroplanes. After that one tries to prevent the enemy from doing the same. This gave rise to the chaser, rapid and climbing very quickly so as to dominate the adversary, a favorite position in aerial combat. Aeroplanes of this type cannot be large, a condition which limits their artillery and its caliber. The smaller the machine the better, as the pilot is at the same time the gunner.

The nose of the Spad single-seater battleplane, showing the method of housing the engine



Side view of the Spad battleplane, which develops high speed and is an excellent climber


A Nieuport single-seater battleplane of recent type, mounting three machine guns

The first requisite for fighting in the air, just as at sea, is to have sufficient speed to be able to overtake the enemy and compel him to fight, and also to be able, in case of need, to avoid an engagement. There are two speeds which can be used either for overtaking or escaping from the adversary—horizontal and vertical speed.

In regard to vertical speed, the question is further complicated by another consideration. There is not only the speed at which the machine can climb, but the maximum altitude it can reach, or the "height of its ceiling," to use French aerial slang. In practice ascensional speed and maximum altitude generally go hand in hand, although they do not always combine with great horizontal speed.

Another necessity is for the machine to be very handy so that it can make sudden turns to escape, and can also follow such turns as may be made by the adversary. The ideal is a small but powerful machine, with not too much surface, giving good results in proportion to engine power, and offering the least possible resistance to the air. In practice, these conditions are fulfilled by biplanes or monoplanes, with engines of 100 or 150 horse-power, with the propeller in front, capable of carrying a load of about 400 pounds.

Most armies having captured one or several of the enemy's machines, their construction is no longer a secret, and some of them may be mentioned. Till recently the French pinned their faith on an improved and speedier type of the well-known Nieuport, a monoplane upon which many records were made in the early days. Still faster is the "Spad," a tiny biplane illustrated on the facing page.

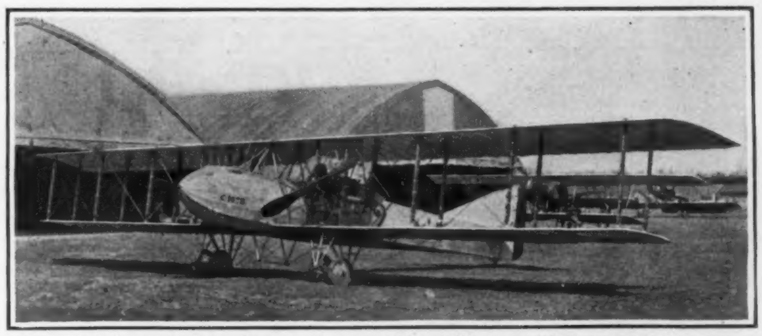
The Royal Flying Corps (British) have for some time been using small but very swift biplanes, which undoubtedly give the pilot a clearer view of his surroundings than the single-plane machines, an important consideration both in fighting and in landing. The air service branch of the English navy, however, prefer Nieuports.

For several months last year the supremacy of the air was in the hands of the Germans by reason of their Fokkers. These were monoplanes with a wing spread slightly under 40 feet, fitted with only an 80-100 horse-power rotary engine.

Probably even better than any of the above is the American-built Curtiss triplane, a bijou machine, the planes of which are only 25 feet in spread. This little machine is said to have a climbing speed of 10,000 feet in ten minutes, and a horizontal speed range of 45 to 120 miles per hour.

All these various kinds of chasers are also used to convoy and protect the slower and heavier bomb-dropping machines should they be attacked by enemy aircraft.

The armament of nearly all these battleplanes is similar. It consists of fitting a machine gun so fixed as to point along the axis of the machine. The pilot, who is alone, directs the nose of his aeroplane at the enemy, and fires across his propeller. Two plans were tried for preventing the propeller from being broken by the bullets. The first consisted of stopping the machine gun whenever the propeller came within the field of fire, but practical experience showed that frequent stopping, with propellers making 1,200 revolutions a minute, ends in putting the machine gun out of order. Designers, therefore, contented themselves with fixing steel plates on those parts of the propeller which were liable to be struck by bullets, the steel plate serving to turn the bullet. According to a mathematical calculation of probabilities, the two propeller blades, in this part of their course, occupy about 20 out of the 360 degrees of a circle. On the average, therefore, only about one bullet out of every eighteen fired is wasted in this manner.


Twin-engine Caudron tractor, used in artillery spotting operations

In the German Aviatiks of the latest pattern, one of which was captured in France, the passenger is placed in front of the pilot, and moves his machine gun rapidly along two parallel steel bars outside the two edges of the fuselage. Two catches, placed in front, prevent the line of fire coming within range of the propeller, which is, of course, placed in front of the marksman. His range of fire thus extends over quite a field. The carbine, which cannot cope with the rapid fire of the machine gun, has practically gone out of use, but some German aeroplanes have been fitted with automatic rifles, certain of which, while lighter than machine guns, can carry a reserve of 25 cartridges equal to that of a small machine gun. The Germans have also succeeded in using the full-sized flexible belt of 250 machine gun cartridges. Probably, however, the English now possess, in the Lewis, the best machine gun for aeroplane work.

As regards seaplanes, they have hardly made such rapid strides in constructional improvements as the land machines. The well-known Curtiss flying boat still leads the way for all-round usefulness, and has been adopted as a standard by many of the warring powers. The chief advancement in their building seems to be a constantly increasing size with a corresponding increase of engine power. It is not improbable that the hydro-aeroplanes of the near future will be huge machines carrying heavy armaments and large crews. And in all probabilities such machines will ultimately be the main answer to the U-boat peril.

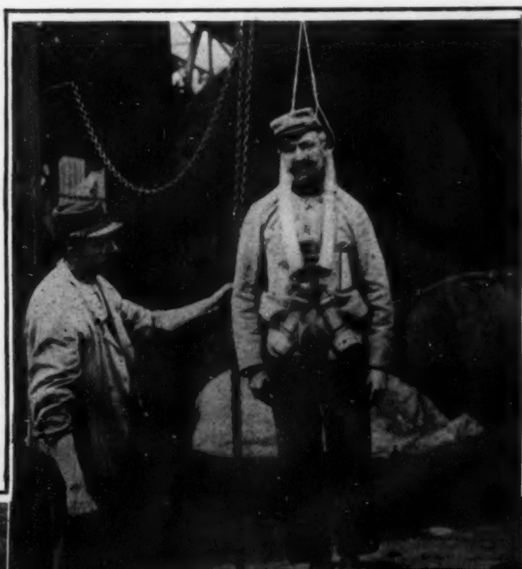
The Real Eyes of an Army—the Modern Kite Balloon

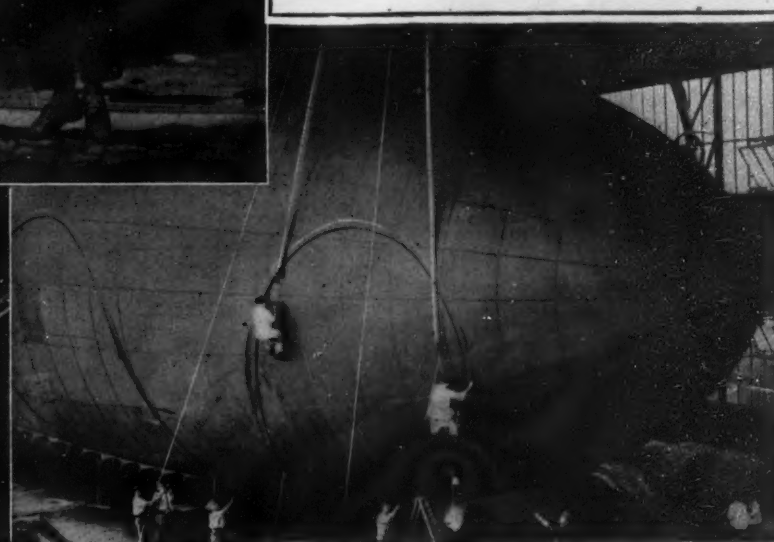
WHILE admittedly less spectacular than the aeroplane, the cumbersome kite balloon, tugging away at its mooring cable in a gentle breeze, is invaluable in the present war. For artillery spotting and general observation work it is in some respects superior to the aeroplane; but its employment is quite apart and distinct from that of the heavier-than-air craft.

Kite balloons are primarily intended for the regulation of artillery fire, particularly in connection with heavy batteries. Whereas the observer in an aeroplane is constantly shifting his position while on observation duty, travelling all the while at a high rate of speed, the kite-balloon crew has all the advantages of a fixed post, which makes for maximum accuracy in spotting shell hits. The kite-balloon crew has access to a large map of the territory under observation, as well as powerful binoculars which permit enemy positions to be carefully studied. Perhaps the main advantage of the kite balloon is to be found in the fact that the crew is always in direct communication with the battery by means of a telephone line, and the effect of different shots can be immediately telephoned to the battery commander.

Two observers comprise the usual crew of a kite balloon, which means that while one observer is spotting for his battery, the other can keep an eye on enemy movements and enemy counter-battery work. Should an ammunition train or body of troops appear within gun range, the second observer can immediately telephone to his battery to fire one or more shells in the direction of the new target whose position is indicated by the number of degrees right or left of the previous mark. The second observer can, if desired, do general observation work; but in practice one balloon confines its activities to spotting exclusively, leaving the matter of general observation to other units.

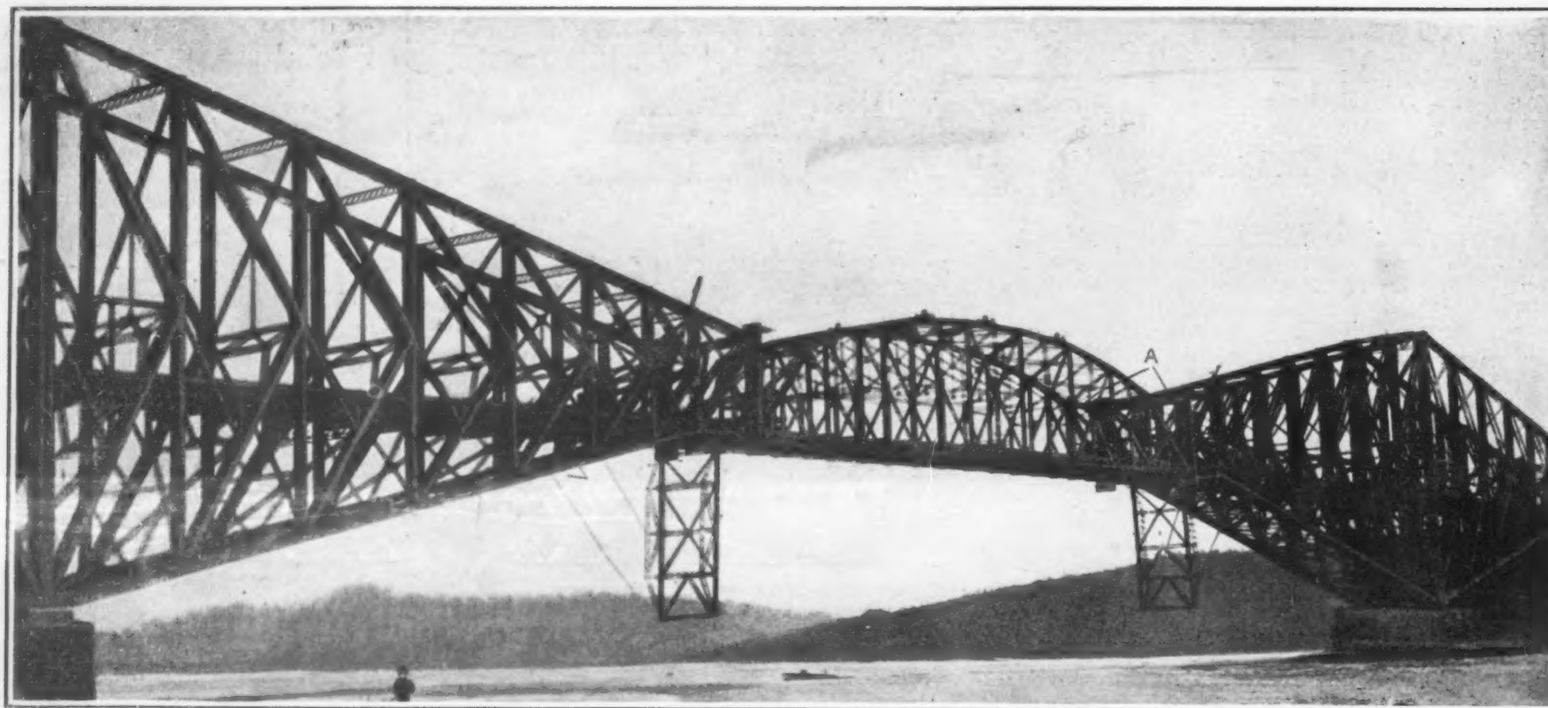
During an infantry attack the kite-balloon observers are generally busy maintaining a liaison between the battalion or company commander in the front line and the brigade and divisional headquarters in the back. Artillery barrages are often controlled from balloons.





Above: Testing the parachute harness of a kite-balloonist. *At the left:* What the kite-balloon observer sees of trench warfare. *At the right:* Women workers making repairs on a French kite balloon.

Unconventional views dealing with the kite-balloon in the air and in the repair shop



The 640-foot suspension span of the Quebec bridge in place between the cantilever arms

Completion of the World's Greatest Cantilever Bridge

Lifting Details Which Resulted in the Successful Raising of the Huge Center Span

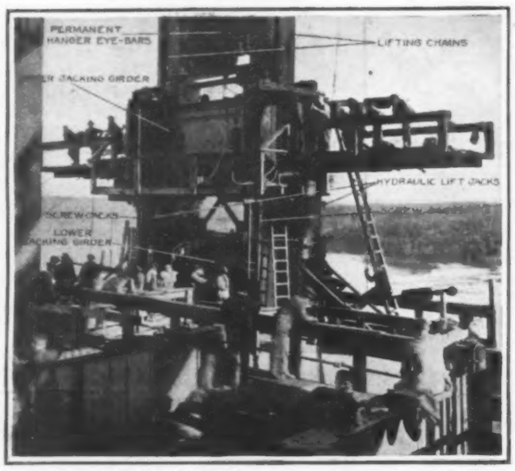
IN last week's issue of the SCIENTIFIC AMERICAN, we told of the raising of the 640-foot suspension span of the Quebec Bridge into position between the cantilever arms, which marked the triumphant culmination of the great engineering battle fought so persistently for over a decade. It is true the bridge is not yet completed. The new span must be floored, and the railroad tracks have yet to be laid before the bridge will be available for traffic. This may take about six weeks, and probably by the end of the year all work on the bridge will have been completed, with the exception of painting the structure.

Although our story of last week gave the main feature of the work, the chief interest lies in the details of the lifting apparatus and the method of supporting the span during raising. These details we are now enabled to give through the courtesy of *Engineering News Record*, which has placed at our disposal the data collected by Capt. Harry Barker, its personal representative at the work.

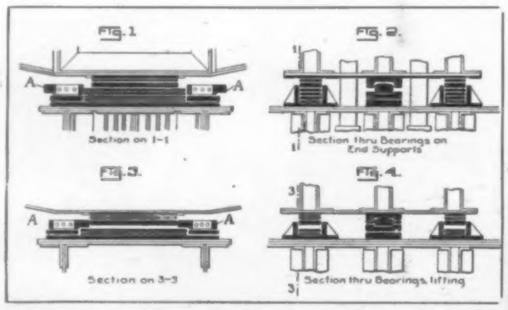
It will be recalled that last year a method of suspension was employed in which two rocker pins, disposed at right angles one to the other, were provided at each corner of the span, between the span and the lifting girders or "chairs" to which the chains were attached. Each pair of pins was supported in a steel casting. The collapse of the span has been attributed to the breaking of one of these castings. The break was at such an angle that it kicked out the lifting girder at this point and immediately the span toppled over into the river, buckling as it fell. Interest, therefore, centers on the method of support used this year and in the precautions taken to avoid a repetition of the disaster.

One of the faults of the last year's design was the fact that only one bearing was provided at each corner of the span and no additional bearings were provided to come into play in case of an emergency. This year there were three: one rocker bearing for service during the raising of the span, and on each side of this a sliding bearing for use during erection and also for emergency use in case of accident to the rocker bearing. The photograph of the lifting girder shows the bearing pockets for the sliding shoes and the rocker plate, while in another photograph the sliding shoes and bearing for the rocker plate are shown under the span corner. This photograph was taken, of course, before erection, while this member was lying in the yards. The two outer pockets of the lifting girder were filled with six strips of lead each, above which were two steel filler plates that fitted the pockets closely, to prevent extrusion of the soft metal. Above this was a polished bronze bearing plate. The purpose of the lead was to give practically a floating bearing which would distribute the load uniformly. With the filler plates in position the rocker plate in the center pocket was relieved of load. This rocker plate consisted of a piece of nickel steel of rectangular form, except for its upper surface which had a cylindrical face with a two-foot radius. A cross-section of the bearings is shown in Fig. 1, while a longitudinal section through one of the sliding bearings is shown in Fig. 2. It is very evident that during the construction of the span there was

(Concluded on page 260)

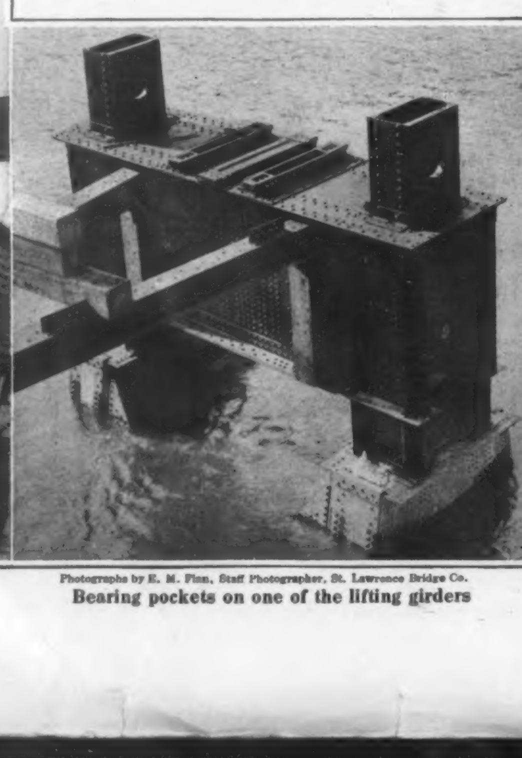


A pair of hydraulic jacks on one of the cantilever arms, lifting a corner of the span



Sectional views of the bearings when on end-supports and when lifting

Shoes and rocker bearing under the span corner



Photographs by E. M. Finn, Staff Photographer, St. Lawrence Bridge Co.

Bearing pockets on one of the lifting girders

General view of the hoisting equipment

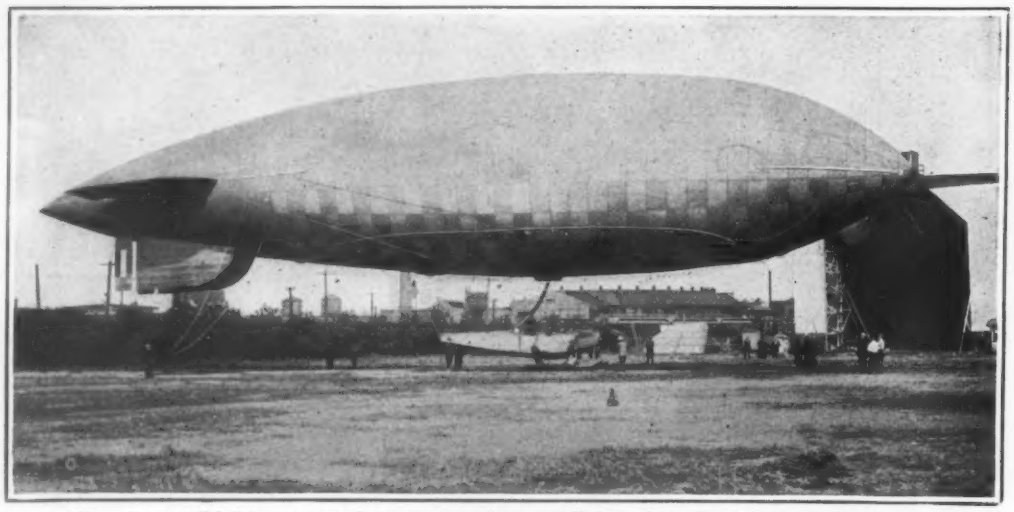
SOME LEADING TYPES OF GERMAN AEROPLANES FOR 1917

Machine	Type	No. of Seats	Span Upper	Span Lower	Gap	Chord	Length O.A.	Engine	Total h.p.	No. of Guns	No. of Bombs
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.				
Albatros	D. II	1	27 8	26 3	4 2	5 3	24 0	Mercedes	175	2	0
Albatros	D. III	1	29 6	28 8	4 10	4 10	24 0	Mercedes	175	2	0
Roland	D. II	1	29 6	28 0	4 4	4 9	22 6	Mercedes	175	2	0
Halberstadt	D	1	28 6	25 9	4 3	4 10	24 0	Mercedes or Argus	120	2	0
Fokker	—	1	29 6	29 6	4 3	4 10	24 0	Mercedes or	175	2	0
								Oberursel	100	—	—
Rex	D. II	1	—	—	—	—	—	**Rex Rotary**	100	1	0
Roland	C	2	33 0	33 0	4 0	5 3	—	Mercedes	175	1	—
A.E.G	C. IV	2	42 6	41 0	6 2	5 5	23 6	Mercedes	175	2	4
L.V.G.	C. IV	2	44 6	—	—	6 5	28 0	Mercedes	235	2	4
D.F.W. Aviatik	C. V	2	43 6	42 0	5 6	5 9	—	Benz	228	2	6
Albatros B.F.W	C. V	2	41 3	40 0	5 10	5 10	28 0	Benz	225	2	4
Rumpler	—	2	—	—	—	—	—	Mercedes	260	2	6
Gotha	G. I	3	78 0	72 0	7 2	7 6	41 0	Two Mercedes	520	3	14
Albatros Bü	D. I	1	28 4	26 9	5 3	5 9	24 0	Mercedes	170	2	0
Aviatik	—	2	41 0	35 4	6 4	6 1	26 3		—	2	0
A.G.O. Pusher	—	—	—	—	—	—	—		—	—	—

Made-in-America "Blimp" Type Dirigibles for Our Coast Patrol

ACCEPTANCE by the Navy Department of the first of the two huge "Blimp" type non-rigid dirigibles built for coast and harbor patrol by an American constructor, justifies the confidence of our industries that they can take care of all our war needs. Indeed, we have attempted very little in the dirigible line before now; and for that reason the ease with which our first Blimp passed the exacting tests of the Navy is all the more encouraging.

When a well-known concern of Akron, Ohio, was awarded contracts for two Blimps, it immediately sought out an expert in this line of aircraft construction. The services of M. Henri Julliot, the French aeronautical engineer who has designed many of the British and French lighter-than-air craft now engaged in coast and harbor patrol, were soon secured; and with him came to this country a large staff of assistants, among them a half dozen girls with a special training in balloon manufacture.



"Blimp" type dirigible—a cross between aeroplane and lighter-than-air craft—recently accepted by the U. S. Navy after successful test flights

With M. Julliot and his staff as a nucleus, a manufacturing plant was soon established and work started on the dirigibles. Under the ever-watchful eye of the French expert it required just four months to complete the first machine, which, during its recent tests, flew for a period of eight hours over one of our largest cities.

Who's Who in the Flying Corps as Disclosed by the Insignia

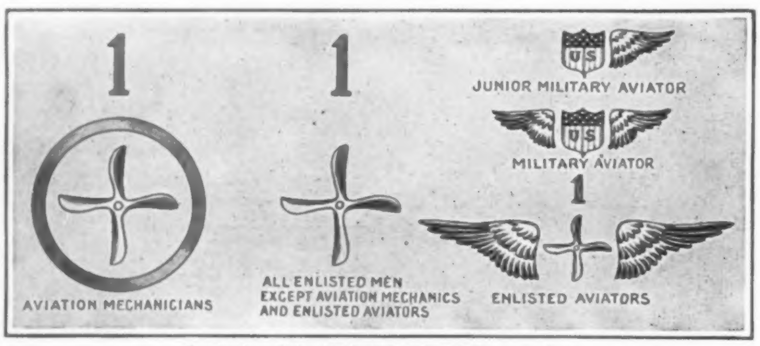
OFFICERS of the Aviation Service who are Military Aviators shall wear an insignia on the left breast, the insignia to be embroidered in silver on blue background and shall be two wings with the shield between, the wings shall be three inches from tip to tip, each wing shall be 1⅜ inches long and 9/16 inches wide at center ends; the shield shall be 9/16 inches high and ⅝ inches wide with letters U. S. ¼ inch high in the center below the horizontal cross lines. Junior military aviators shall wear on their left breast the same insignia described for the military aviator except that the right-hand wing shall be omitted, the insignia consisting of one wing to the left of the shield. Letters U. S. are in gold.

Enlisted men of the Aviation Section shall have a navy blue cap let in at the sleeve head-seam and extending down the sleeve 5½ inches from the point of the shoulder. All men as hereinafter specified will wear the insignia as described.

A four-bladed propeller with a center 3¾ inches from point of shoulder, embroidered in white, the propellers to be 2 inches in diameter, two blades horizontal and two vertical, ¾ of an inch above the top tip of the vertical propeller blade, a figure showing the number of the squadron to which the man belongs, 1 inch high and embroidered in white.

Aviation mechanician, same as above with white embroidered circle added, inside of circle to be 1¼ inches from propeller center, the outside of circle to be 1⅜ inches from center.

Enlisted aviator, on the same blue background shall be embroidered in white, the insignia as described. A pair of wings with a 5-inch spread with crossed propellers between them, each wing to be 1⅞ inches long and ⅞ inch high at the inner edge. Propellers to be 1 inch across. One-fourth inch above the top tip of the vertical propeller shall be embroidered the number of the squadron to which the man belongs in figures ½ inch high.



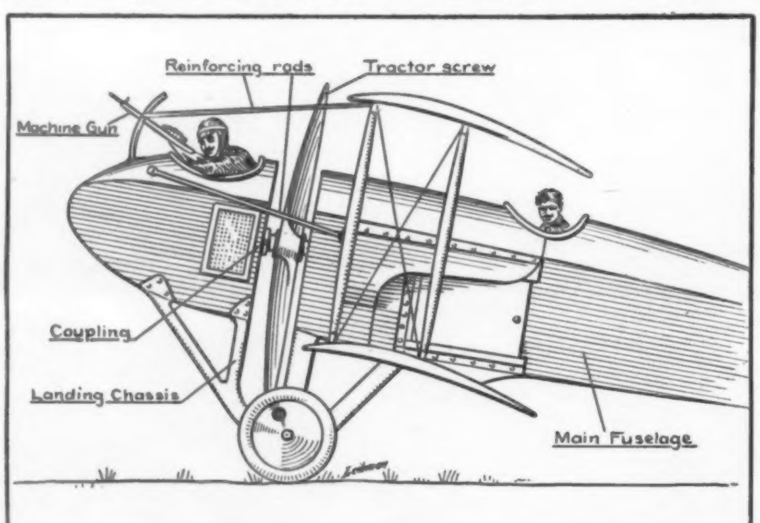
Insignia of the United States flying service

Is This the Solution of the Battleplane Problem?

THE arming of aeroplanes has brought about many problems which the aircraft constructor must continually struggle with, for the military efficiency of a battleplane demands that the machine gun be placed where it can be brought to bear upon the enemy in the most telling manner. In a machine of the pusher type the problem of mounting the gun is simple, for the nacelle in front affords an unobstructed sweep for gun fire. But the tractor type is in universal favor, because of certain other advantages, and it is here that the problem of mounting the machine gun is complex. The gun must be pointing in the direction the machine is traveling; and to this end the gun is either mounted above the planes, so as to clear the tractor screw, or on the engine hood and equipped with a synchronizing device permitting a stream of lead only when the screw blades are not in the line of fire. Machine guns have also been mounted to fire through a tractor screw provided with armor at the points of fire, so that the bullets which chance to hit the blades are deflected. But this results in a 30 per cent waste of ammunition—and in air battles no ammunition can be wasted.

The designer of the famous Spad biplane used largely by the French and British air forces has suggested a novel form of battleplane which is perhaps the solution of the problem. To a tractor biplane of the usual high-speed model he adds in front a nacelle, which is attached by a free coupling with the propeller shaft and by a pair of members which form part of the landing chassis, in the manner shown in the accompanying line drawing. Thus the machine is neither a tractor nor a pusher type, and it appears that the advantages of both types are retained in this compromise.

The machine gun is mounted in front of the nacelle, and the gunner has an unobstructed view through an arc of 180 degrees in the horizontal plane and almost 90 degrees in the vertical plane; and with the machine gun properly mounted it should be possible to bring the fire to bear on any point within these ranges.



Gunner's nacelle in the Spad tractor-pusher type of battleplane

Types of French battleplanes now in use, showing a Nieuport at the left, a Spad tractor-pusher in the center, and two Nieuports at the right

The "Seventh Inning" in a Factory

A NOVEL rest period, introduced into an American manufacturing plant in Brooklyn and called the "seventh inning stretch," is the latest innovation in industry. At 3.15 each afternoon the telephone operator rings a signal and all work stops. For the next 15 minutes desks are deserted, typewriters and bookkeeping machines are silent, dictaphones are shut off, and everybody from the president of the company to the office boys enjoy a recess. The idea of a 15-minute recess each afternoon was suggested by an officer of the company, who realizes that in order to get the best possible work from their employees, neither body nor brain shall be overworked. Employees working under considerate conditions take pride in their work, an intimate interest in the success of the company, and find the road to advancement made easier for them.

Acid-Proof Clothing

WHEN the inventive minds of the textile industry have a moment to spare they might consider the requirements of the workers in chemical and other factories for an acid-proof clothing material. Strong mineral acids are now being made and splashed about in many works on an unprecedented scale and no entirely satisfactory material for workmen's wear has gained adoption. Rubber is an efficient resistant but rubber suits are no garments for piece workers and use of rubber is confined in practice to gloves and shoes. The best approved clothing is wool, and on the whole nothing better than heavy khaki has been found, but the cloth is dear in view of the short life of even the best of it, and the workers in some of the acid shops are buying second-hand clothing.

It is no uncommon thing for men employed in the wet processes of the manufacture of explosives in England to spend ten shillings a week at the marine store. In lieu of shirt sleeves they wear stocking legs, over which the gauntlet of their gloves is pulled. One pair of trousers being not sufficient protection they put on two pairs, and not infrequently find the pockets of the inner pair rotted by acid at the end of the first day. Cotton is useless, whether as clothing or as sewing thread, and silk has apparently been deemed too expensive.

Modjeski

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of SCIENTIFIC AMERICAN.

Pertaining to Apparel

CORSET COVER.—ROSA GROSS, 640 West 139 St., New York, N. Y. The patent relates to corset covers, chemises, brassieres, and dress and waist linings. The object is to provide armpit concealing extensions at the sides of the body of the garment, in combination with means whereby the extensions are kept closely confined to the arms in all positions, without however being uncomfortable or restraining from free movement the invention is neat and attractive in appearance and comparatively inexpensive.

Electrical Devices

ELECTRIC SPEED OR PRESSURE CONTROL DEVICE.—C. A. MULLEN, 101 Chelsea St., Sistersville, W. Va. The invention relates to governors for explosive engines responsive to the pressure of fluid delivered by a pump driven by the engine or to speeds of a moving part driven by the engine. A specific object is to provide an attachment which is applied to the face of the indicator, whereby an electrical contact cooperates with the needle or hand so that when the latter reaches a predetermined position the electric circuit will be closed to short-circuit the spark plug of the engine.

MICROPHONE WITH CARBON POWDER FALL FOR STRONG CURRENTS.—G. B. MAREI, Cornigliano Ligure, Italy. The invention comprises the combination of a microphone employing a powdered carbon contact, a supply of granulated carbon, movable parts controlling the fall of the carbon, and a second microphone actuating the movable parts which act on the falling carbon constituting the contacts medium.

Of Interest to Farmers

CANE HARVESTER.—I. BALSEIRO, care of Thomas Rodriguiz, La National, 27 Ft. Green Place, Brooklyn, N. Y. The invention relates to harvesting machines and has particular reference to self-propelled machines designed especially for stripping and delivery the cane in short lengths into the carts or cars. Another object is to improve the facilities for guiding the machine and for manipulating the cutting devices operating adjacent to the ground.

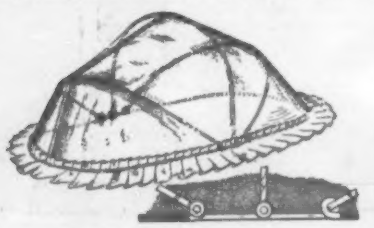
COTTON-HARVESTER.—J. J. OGDEN, 500 Elenore St., New Orleans, La. This invention relates particularly to a self-propelled vacuum induced suction machine for picking cotton, the object is to provide a machine capable of operation in the field without injuring or otherwise endangering the cotton plants during the first and second pickings, so as to impair their production for the second or third crops. A still further object is to provide a vacuum pump, and means whereby to provide for both the suction and discharge lines of the pumps in handling the cotton.

ENSILAGE PACKER.—A. LAWRENCE, Medicine Lodge, Kans. The objects of this invention are to provide a packer including packing rollers, one of which is power driven and coned or tapered to cause it to travel circularly, the total weight of the packer including the weight of the motor, as well as the weight of the workman, will be imposed on the ensilage, and the whole caused to travel about a relatively fixed centering post as an axis.

FARM TRACTOR.—C. E. MOFFITT, Supt. Sidney Public Schools, Skiney, Iowa. The invention has for its object to provide mechanism of the character specified, for permitting the cultivating devices carried by the tractor to be shifted and controlled through the operation of the steering mechanism of the tractor, which consists of a steering wheel at each end of an auxiliary frame, amounting for each steering wheel journaled in the auxiliary frame on a vertical axis, and means for simultaneously swinging the wheels.

Of General Interest

CANOPY.—H. ULRICHSEN, Midland Park, S. C. The object of the invention is to provide a folding canopy especially adapted for use with babies, it may be arranged over the child lying on the floor, or in bed, it will prevent the entrance

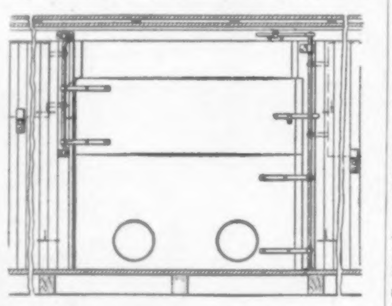


PERSPECTIVE VIEW OF CANOPY

of insects, such as flies, mosquitos and the like, it may be folded into very small compass for transportation. In order to provide a neat ornamental finish, a ruffle is arranged around the edge, helping further to exclude insects from the frame.

CEMENT.—T. MONIWA, Akasaka Tokyo, Japan. The object of the invention is to provide a cement by means of which such substances as glass, enameled ware, glazed porcelain, earthenware, and the like having smooth surfaces and of a non-absorbent nature, and which are generally recognized as being almost impossible to cement together or to other substances with perfect cohesion, can be cemented together in such a manner that cohesion will be practically perfect and permanent, and without any staining. The invention consists of petroleue, asphaltene and a non-melting matter such as powdered quartz, asbestos or the like.

GRAIN CAR DOOR.—G. A. SPELBRINK, Ivanhoe, Minn. This invention has for its object to provide a grain car door which will not permit leakage, while so constructed that it may be easily operated. Novel means are provided for



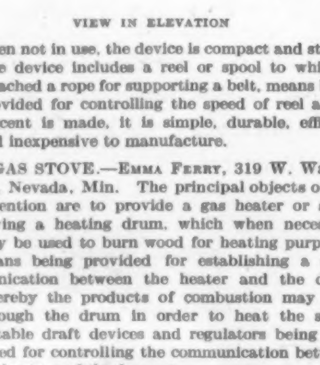
SHOWING PORTION OF INTERIOR OF CAR, WITH GRAIN CAR DOOR

holding the door space from the door frame, and also for holding the door out of the way when in open position. There are auxiliary doorways. Flanges are so constructed at the sides of the door, that leakage is prevented.

FILM-FEEDING MECHANISM FOR CAMERAS.—L. F. CORRODI, Abbeville, La. In film cameras, a sight opening is provided in the casing of the camera through which a number on the film is visable, often times the film is unwound too much, by reason of the non-observance of the number, there is no means for rewinding the film to adjust it to proper position. The present invention provides a take-up device detachably connected to the take-up spool, and an indicator which is operated by the take-up device to rotate in one direction when the film is being wound upon the take-up roller and which may be rotated in the opposite direction should the film be accidently unwound too much for proper exposure.

PORTABLE FIRE-ESCAPE.—A. W. SMITH, Richmond Terrace, New Brighton, N. Y. The object is to provide a fire escape arranged to permit firemen to quickly place it in position on the sidewalk in front of a building, allowing persons in the building to pass from any window to the fire escape and to be lowered by the latter to the sidewalk, to accomplish this result use is made of a group of posts, with carriers mounted to slide up and down, hoisting means connected with the carriers to raise and lower them, and a platform within the space of the posts and attached to the carriers.

FIRE ESCAPE.—M. O. MCLAUGHLIN, York, Neb. The principal objects of the invention are to provide a fire escape capable of attachment to a window casing in such a manner as to be normally folded against the wall within the room



VIEW IN ELEVATION

when not in use, the device is compact and strong. The device includes a reel or spool to which is attached a rope for supporting a belt, means being provided for controlling the speed of reel as the descent is made, it is simple, durable, efficient and inexpensive to manufacture.

GAS STOVE.—EMMA FERRY, 319 W. Walnut St., Nevada, Min. The principal objects of the invention are to provide a gas heater or stove having a heating drum, which when necessary may be used to burn wood for heating purposes, means being provided for establishing a communication between the heater and the drum whereby the products of combustion may pass through the drum in order to heat the same, suitable draft devices and regulators being provided for controlling the communication between the heater and the drum.

HOLDER FOR INSECTICIDES.—L. ABADIE Abbeville, La. The prime object of the invention is to produce a device, for holding insecticides or insect repelling substances, in which the poison may be safely placed and access to the same by children be made practically impossible. Use is made in carrying this out, of a casing made cylindrical, and a receptacle to hold liquid poison, the casing having holes variously positioned permitting the entrance of insects.

SAMPLE CARD.—B. F. STENE, 644 First Ave., New York, N. Y. The invention relates to cards adapted for use in the piece-goods art for displaying samples or replicas of samples of woven textile material such as gighams, percales, silks and ribbons, the samples are protected on the surface by an integrally formed raised guard surface.

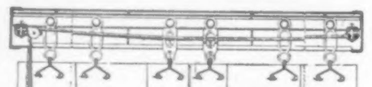
METER READING DEVICE.—R. A. CASSON, 2815 E. First St., Duluth, Minn. The object of this invention is to provide mechanism by means of which meters submerged by dirty water may be read. The device comprises a tapering casing having its large end open and adapted to fit about a meter to permit the same to be read, a disk of transparent material held at the small end of the casing, an air-tight connection between the disk and the casing for driving out the water over the meter, the casing having means for supporting an illuminating means to illuminate the face of the meter.

COATING COMPOSITION AND PROCESS OF MAKING THE SAME.—H. K. KISO, 15 and 21 Park Row, New York, N. Y. The invention relates to the production of an insoluble material from the root of certain plants and the process of producing this material. The process consists of crushing the root of the Conopholis, whereby a thick paste is produced, after which it is heated causing the preparation to become more liquid, when coated with this material an article becomes waterproof, and after the material has dried will become substantially fireproof.

GAS JOINT OR SEAL FOR CLOSET BOWLS—J. R. WILLIAMS, 101 Park Ave., New York, N. Y. The invention relates to seals for closet bowls the object being to prevent leakage of sewer gas, by a construction which is automatically maintained in a proper operating condition. Another object is to provide a seal at the bottom of the bowl arranged as a trap and acting in connection with a specially constructed bowl for supplying the trap with fluid.

COAL-HOD.—J. KARSSEN, Holland, Mich. The invention is a coal hod comprising a hopper shaped body, which may be filled with coal and set upon the top of the stove and is so constructed that the coal may be shoveled out at the bottom of the hod on a level with the top of the stove.

CURTAIN POLE.—F. J. BISCHOF, 160 Gratiot Ave., Detroit, Mich. The invention provides a pole with curtain supporting means of ready adjustment. The supporting means consists of hangers which extend through a slot in a guide,



LONGITUDINAL SECTION VIEW

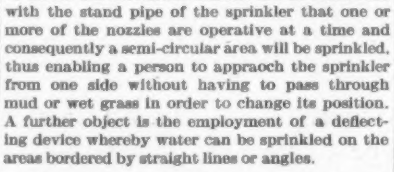
the hangers having an opening in which a bearing bale is disposed the bearing ball engaging the inner side of the guide. An operating cord which extends in the casing being adjustably secured to certain of the hangers.

BOOK.—R. MAYHEW, 220 Wadsworth Ave., New York, N. Y. The object of this invention is to provide a book having a theme or story set forth in text, cuts or music, and having a sound recording record so that when the text or cuts or music have been read, or before, the sound producing record may be placed on the sound-producing machine and operated. By this means the story or song which is in the book may be heard at the time the text is read.

LAWN OR GARDEN SPRINKLER.—C. L. KELSO, Cle Elum, Washington. A specific object of the invention is to provide a sprinkler in which the revolution nozzles are so connected with the stand pipe of the sprinkler that one or more of the nozzles are operative at a time and consequently a semi-circular area will be sprinkled, thus enabling a person to appraoch the sprinkler from one side without having to pass through mud or wet grass in order to change its position. A further object is the employment of a deflecting device whereby water can be sprinkled on the areas bordered by straight lines or angles.

SMELTING PROCESS.—N. TESTRUP and T. RIGBY, London, England. The invention provides for a method of smelting metalliferous ores by means of peat blocks which have been subjected to heat treatment adapted to set free the water contained therein, removing said water by filter pressing, forming a solid material into blocks and admixing said blocks with the ore as part of the furnace charge so that the peat is finally rendered suitable for use as a reducing agent by the waste heat of the smelting process.

VENTILATOR.—W. G. HUTCHISON, Valparaiso Ind. This ventilator is especially adapted for use in railroad cars, a casing is provided which may be arranged in the ventilator openings at the tops of the cars, baffle plates arranged parallel



HORIZONTAL SECTION THROUGH A VENTILATOR IN PLACE

and overlapping form a series of passages extending longitudinally of the casing, wherein a door is hinged to the opposite end to open outward and a partition is arranged at the inner side of the door between the same and the baffle plates.

AUTOMATIC LINE-SPACING DEVICE FOR TYPE-WRITERS.—G. E. CALLAWAY, care of Dr. R. R. Braswele, Jenkins Bldg., Mansfield, La. This improvement in automatic line spacing devices for typewriter has for its object to provide means operated by carriage of the typewriter when it nears the limit of its movement in writing direction for automatically setting up a new line.

TENT-FLAP CLOSING DEVICE.—J. H. HERRSTEIN, 317 Kuhn Bldg., Spokane, Wash. The principal objects of the invention is to provide a device whereby the door or flaps of a tent or tent window may be drawn together or loosened for opening at will, to provide a device with a double channel for engaging the edges of the tent closure and further provide a buckle or clamp for removably securing the slide to the strip. The device is extremely simple, durable, and inexpensive to manufacture.

SANITARY BOTTLE CAP.—O. WESTOVER, address Capt. Oscar Westover, West Point Academy, N. Y. The object of the invention is to provide a sanitary bottle cap, more especially designed for use on babies' milk bottles of the Hygeia type to exclude dirt and germs, and at the same time to permit the entry of air; but also

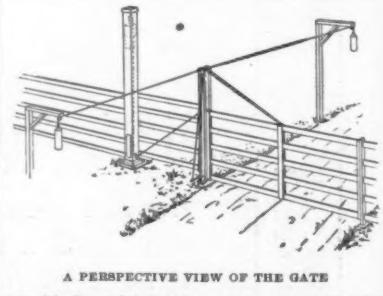
SHOWING NECK OF A BOTTLE PROVIDED WITH CAP

for use on any glass bottle or jar whose contents after preparation or first opening require such protection. The cap comprises a body having a central opening, and a disk of non-absorbent porous material held in the opening by a cap ring.

PACKAGE TIE.—D. J. CONNELL, 736 So. Montana, Phelan Hotel, Butte, Montana. The invention relates to means for fastening a tie-cord about a package, it is more particularly intended to provide a package tie that may be conveniently and economically employed in the tying of packages of letters in post offices, the particular object being to provide means whereby the cord may be instantly tightened about the package and securely fastened.

ATTACHMENT FOR CIGAR MOLDS.—G. J. PRENTICE, 212 St. Nicholas Ave., New York N. Y. In molds heretofore employed in the making of cigars, there is no means for detaching the surplus tobacco from the head of the bunches when the same are placed in the matrices carried by the lower section of the mold, other than by pulling said surplus off by hand; the pulling drags the surplus off leaving a portion of it extending from the small opening at the head of the matrices; it also forces the tobacco at the head of the bunch into the small opening causing it to become compact which is the principal cause of cigars not smoking freely. The present invention is to overcome this difficulty.

GATE.—J. W. LOVELAND, care of Frederick C. Koehnle, Lincoln, Ill. An object of the invention is to provide a simple and inexpensive tilting gate



A PERSPECTIVE VIEW OF THE GATE

operable by weights arranged to vary their effect upon the gate, so as to eliminate shocks and wear upon the various parts of the gate mechanism.

BAG FASTENER.—W. R. GATLIN, Hopkinsville, Ky. The invention relates to paper bag fasteners and has particular reference to a fastener which constitutes reinforcing means at the mouth of the bag, the object is to provide a simple rigid and durable fastener which does not permit the sides of the bag to buckle. A flap forms a part of the bag adapted to fold over the mouth without folding the bag proper at the mouth and a foldable metalic strip secures the mouth of the bag.

COLLAR AND STIFFENER THEREFOR.—M. FINKLESTEIN, 1800 Seventh Ave., New York, N. Y. An object of the invention is to provide a soft shirt collar and stiffener therefor, arranged to support the neckband with a view to maintain the shape of the turndown portion and to prevent it from wrinkling or wilting from perspiration. Another object is to permit of conveniently removing the stiffener. In accomplishing the desired result use is made of a collar having a neckband provided with a pocket or recess open along the lower edge, and a stiffener removably held in the said pocket.

Hardware and Tools

PERMUTATION LOCK.—C. H. HIPP, Engineer C. A. C., Fort Mills, P. Q. The object of the invention is to provide a lock more especially designed for locking the steering shaft of an automobile motor cycle, bicycle or like machine against turning by unauthorized persons. Another object is to provide a lock which will be difficult to pick or successfully manipulated by an unauthorized person

SAW-JOINTER.—W. E. GIBBS, 630 E. 24th St., So. Portland, Ore. The invention consists of a frame or supporting bar of suitable size and length, having each of its ends enlarged laterally

(Concluded on page 256)

RECENTLY PATENTED INVENTIONS

(Concluded from page 254)

at the top of t e bar to form a head, and each head is slotted transversel of the bar. A set screw is threaded through each head into the slot and a runner or guide plate is connected with each head.

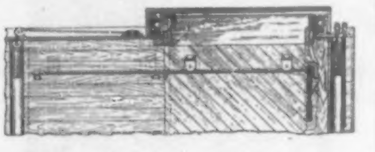
Heating and Lighting

HEATER.—E. G. Ballenger, 805 Healy Bldg., Atlanta, Ga. The inventi n relates to heaters designed for use in connection with internal-combustion e gines for the purpose of keeping the engines warm during the winter month . An object is to provide a heater which will supply sufficient heat for the engine without the risk of an explosion that may be caused by gas leaks under the hood when used on vehicles

Machines and Mechanical Devices

CARBURETER.—C. P. Neats, 89 Sanford St., East Orange, N. J. The object of this invention is the provision of an arrangement which will supply fuel in proportion to the speed of the engine to which it is connected, the fuel is taken up in small quantities and mixed with the air while more or less finely divided before passing into the cylinder of the engine. A still further object is to maintain a certain l vel of oil and a rotatable member operated by the suction of the engine for dividing the oil into fine particles and then mixing it with air previous to the discharge of the oil.

HATCH COVERING.—F. Tetzlaff, 1284 Amsterdam Ave., New York, N. Y. A specific object of the invention is to provide a hatch coverer for barges and other freight carriers, which is slidably interengaged with track rails whereby



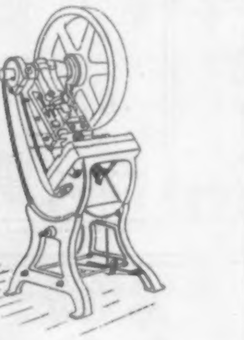
A VERTICAL SECTION OF THE HATCH, SHOWING THE DOOR IN CLOSED POSITION

the cover can slide to and from closed position and be held in place at all times. The inventor claims for it that it insures safety of life, economy in time and labor, speed of operation, protects against damage from the elements and cannot blow off in heavy wind.

PROCESS AND APPARATUS FOR ROASTING COFFEE AND OTHER SUBSTANCES.—P. Malvesin, Sceaux, France. The process consists in effecting the roasting operation in a container heated by suitable means and in which either previously or at any moment of the roasting, air or any innocuous gas has been compressed to a pressure sufficient to prevent the constituent elements of the substances under treatment from becoming vaporized at the temperature employed

HAIR-CUTTING MACHINE.—G. P. Bourdelat, Aberdeen, N. C. The principal object of the machine is to prov de means for rapidly and evenly cutting the hair of the human head, in a manner most comfortable to the person whose hair is being cut, and for conveying all the cut hair together with whatever dandruff may be loosened to a sutable receptacle, so that none of the cut hair will fall from the head onto the clothing of the person.

WASHER CUTTING BIT AND DIE.—W. T. Miller, Spruce Pine, N. C. One of the principal objects of the invention is to provide a bit and die especially designed for simultaneously cutting two washers from mica stock, the



POWER PRESS HAVING BIT AND DIE MOUNTED THEREON

smaller washer being cut from the center blank formed in punching the larger one, thus turning the loss of the center blank (which has heretofore been thrown away) into profit. The machine automatically separates the cut washers from each other from the stock.

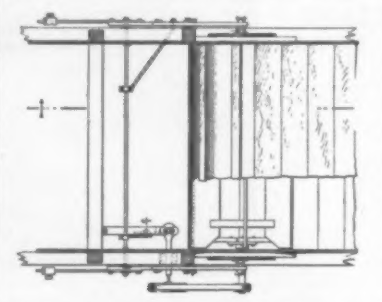
WASHBOARD.—N. Taccone, 40 Gilbert St., Derby, Conn. One of the principal objects of the invention is to provide a washboard which can quickly and conveniently be adjusted to assume various angular positions consistent with the requirments for comfort of its individual user. A still further object is to provide a washboard which may be supported when in use in convenient relation with the washtub, but which will not project into the washing fluid contained in the tub.

SELF-OILING BEARING.—H. G. Vance, 4261a Moffett Ave., St. Louis, Mo The invention provides a bearing wherein the movement of the rotating element will maintain a thorough lubrication of both the rotating and fixed element a cylindrical casing between the shaft and the hub is adapted to contain lubricant, and has radial ports for permitting the lubricant to flow outside the casing, and means for receiving the oil and returning it to the interior of the casing

HYDRAULIC MOTOR.—R. Rivera, Sonsonate, Salvador. Two patents have been granted to Mr. Rivera on hydraulic motors their Nos. being 1,233.913 and 1,233,914. The first provides a novel arrangement of the valve mechanism in which the shifting of the valves to turn the motive fluid first in one direction and then in the other, is accomplished automatically and instantaneously a further object is to provide a valve shifting means in which a weight is actuated in such a manner that by its momentum the valve is given a quick throw. The second patent has for its object to provide a motor which is very efficient because of the novel arrangement of the valve mechanism in which the shifting of the valve is automatic and instantaneous and wherein the usual valve chest arranged adjacent to the cylinder and port to connect directly therewith is dispensed with.

BURGLAR-PROOF SAFE OR VAULT.—H. W. Heller, 105 2d St., Portland, Ore. The invention relates to protective safe or vault work and pertains to the entrance doors and their closing, opening and holding mechanism also to a foot bridge. The outer doors of the safe or vault open or swing inward and a foot bridge extends through the vestibule or vault entrance, from the permanent floor of the room to the corresponding floor of the safe.

WIND-REGULATOR FOR GRAIN-SEPARATORS.—R. R. Hager, Farmington, Wash. The prime object of the invention is to provide means under the influence of a governor driven from a movable part of the separator and acting to automatically regulate blinds controlling the



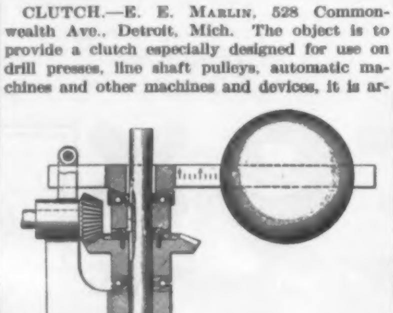
PLAN VIEW SHOWING THE INVENTION APPLIED TO SEPARATOR

admission of air to the fan casing, whereby the wind will be automatically regulated with the speed of the machine, so that when the mahine is fed heavily the blinds open g ving the required amount of wind to hand the extra volume, when fed lightly the blinds will close and reduce the volume of wind.

OILER FOR ELEVATOR AND WEIGHT GUIDE-RAILS.—J. O'Connor, 520 Park Ave., New York, N. Y. An object of the invention is to provide an oiling device which may be readily clamped to the elevator to continually supply oil to the guide rails thereof. A further object is to provide a boxing designed to fit over the guide rail of an elevator, with a filling therefor which will take up any excess oil.

OIL EXTRACING APPARATUS.—F. Strickland, Anderson, S. C. The invention is adapted for the continuous compression of substances such as cotton-seed, linseed, peanuts and beans for extracting oil therefrom in an effective manner. The machine provides a rotary compressor and conveyer which is cylindrical in cross section but differential in diameter, one-half its length being larger than the other, the intervening portion being tapered, the large portion having a spiral groove which serves to receive and feed forward the oil-bearing material.

CLUTCH.—E. E. Marlin, 528 Commonwealth Ave., Detroit, Mich. The object is to provide a clutch especially designed for use on drill presses, line shaft pulleys, automatic machines and other machines and devices, it is ar-

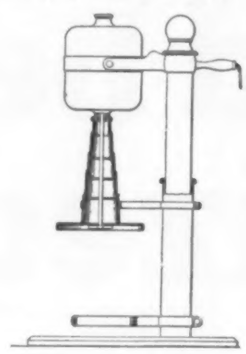


SECTIONAL SIDE ELEVATION OF THE CLUTCH

ranged to prevent overloading of the machine and consequent breaking of the drill or other tool used in the machine, the device also allows of conveniently adjusting and setting the clutch to any desired load.

FRICTION-GEARING.—R. D. George, 4341 Tracy Ave., Kansas City, Mo. The invention relates to gearless transmissions and has for its object to provide a transmission wherein a transmission shaft is arranged between the driving and the driven shafts, the transmission having a fixed and a movable disk which is spring pressed toward the fixed disk, and the driving shaft having a wheel engaging between the two disks and movable toward and from the transmission shaft to vary the relative speed of the shafts, the driven shaft is connected with both disks and an opposite sides of the shaft to counterbalance the thrust thereof.

ATTACHMENT FOR MIXING MACHINE.—I. Tiger and A. Hoch, 952 Fox St., Bronx, N.Y. The invention relates to machines with a motor-driven mixing spindle for mixing malted milk



SIDE ELEVATION SHOWING SPINDLE IN RAISED POSITION

or other beverages. The prime object is to provide a collapsible protective shield, as shown in the figure, for housing the spindle against contamination by flies and dust.

LOCK FOR A SLIDABLE SPUD.—J. P. Karr 409-410 Bass Block, Fort Wayne, Ind. Dredges adapted for excavating canals are provided with spuds or side braces which may be adjusted to extend to the banks on both sides, for the purpose of steadying the scow on which the dredge apparatus is mounted. The invention is an improvement upon a former patent granted to W. Karr, February 6th, 1906, and relates particularly to a safety device for locking and releasing the spud.

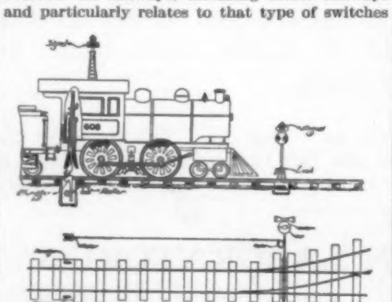
Prime Movers and Their Accessories

INTERNAL COMBUSTION ENGINE.—G. J. Cooper, 1017 3d St. E. Havre, Mont. Among the objects which the invention has in view are: to drive a rotor by means of expanding gases delivered by a stationary member having a plurality of delivery channels for operating upon the rotor; to provide means for delivering a plurality of rotary impulses on the rotor during the revolution thereof.

Railways and Their Accessories

STATION INDICATOR.—R. Watkin, 163 10th Ave., New York, N. Y. The object is to provide an indicator for use on cars, to display to the passengers the next station; in order to accomplish the result, use is made of an endless carrier, signs pivoted on the carrier, and each provided with a lug, and a fixed member adapted to be engaged by the lug on the forward travel of the carrier to swing the sign from vertical display position into an upward non-display position.

AUTOMATIC SWITCH.—H. H. Palmer, 64 Columbia St., Charleston, S. C. The invention relates to means for automatically operating the switches on railways, including street railways and particularly relates to that type of switches



SHOWING SWITCH IN OPERATION AND TOP VIEW

adapted to be operated automatically by trips provided on a car or locomotive and arranged to depress switch-operating plungers in the tracks at the sides. The prime object is to provide means for locking the switch in any position to which it has been thrown

Pertaining to Vehicles

PUMPING DEVICE FOR AUTOMOBILES.—H. M. Cloude, McMillan and Boone Sts., Cincinnati, O. An object of the invention is to provide a device which may be readily applied to automobiles of the existing types, and by means of which air may be supplied to the tires. A further object is to provide a device which may be readily removed and with means for successfully operating the device, even though the pump may be slightly out of alinement with the crank pin carried by the wheel.

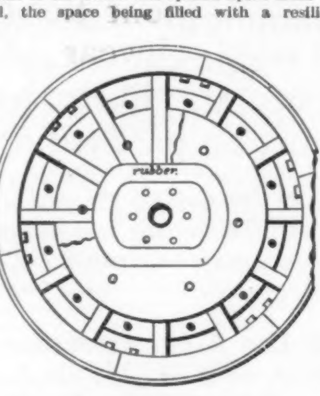
TRANSFER LORRY.—C. W. Stamper, London, England. The invention relates to lorries which are employed for transferring loaded or unloaded detachable vehicle-bodies and similar articles to and from other transport vehicles. The invention consists of a permanently wheeled truck, having four wheels, but devoid of bearing springs, and provided with an end-extension adapted to engage beneath the chassis part of the transport vehicle with which it is designed for use.

ROOF FOR AUTOMOBILES OR OTHER CLOSED BODIES.—W. M. Healey, care of Healy & Co., 1658 Broadway, New York, N. Y. The object is to provide a roof for closed automobiles or other bodies arranged to reduce to a minimum the air vibrations inside of the body, thus relieving the occupants of undesirable sound waves. In order to produce the result use is made of a skeleton roof frame over which is stretched wire clo h supporting a padding of felt overlaid with other suitable material such as enamel-faced leather.

TIRE TREAD.—M. E. Fox, R. L. Ryan, and C. M. Sawyer, 402 W. 1st St. Winston-Salem, N. C. The invention has for its object to provide a device which will protect the pneumatic tire from external injury, and will insure a firm grip upon the grounds, without impairing the resiliency of the tire. This is accomplished by a tire tread of sheet metal shaped to fit the periphery of the tire, the tread being a split ring, the tread is clamped to the wheel by pairs of holding plates secured to the side edges of the tread, each plate having at the end remote from the tread an inwardly extending lug, and means for engagement by the lugs.

SANDING DEVICE FOR VEHICLES.—H. A. Alheit and J. A. Boyken, 121 W. 89th St. New York, N. Y. The invention has for an object a construction whereby sand may be discharged at any time upon the traction surface in front of the wheels of an automobile or of any form of vehicle whereby slipping or skidding is retarded or prevented. Another object is to provide a device for motor driven vehicles constructed so that the exhaust may be automatically turned on to the sanding device for forcing sand on the traction surface beneath the wheels, at the time or perhaps before the brakes have been applied.

WHEEL.—L. J. Rickard care of Walla Walla Meat and C. S. Co., Walla Walla, Wash. The object is to provide a wheel especially adapted for motor vehicle use, wherein the hub is independent of the wheel and spaced apart from the wheel, the space being filled with a resilient



VIEW OF WHEEL WITH SIDE PLATE REMOVED

material to cushion the hub against the wheel The wheel is provided with an open space of oblong form, the hub is arranged within this space, a cushion of solid rubber is placed within the said space between the limiting wall thereof and the hub.

TIRE.—I. N. Keim, 41 Broad St., Mount Holly, N. J. An object of the invention is to provide a tire for vehicle wheels arranged to dispense with an inner inflatable tube, at the same time however, providing a desired cushioning effect. Another object is to allow of readily assembling the parts and fastening the same removably in place on the felly of the wheel, and to permit convenient and quick replacing of a worn out tread by a new one.

AUTOMATIC SAFETY STARTER LOCK FOR AUTOMOBILE ENGINES.—J. V. and T. E. Boyett, 257 N. Conception St., Mobile, Ala. One of the principal objects is to provide an automatic starter lock for internal combustion engines, rendering impossible the coupling of the starter and the motor while the latter is running and thereby to eliminate the danger of damage and breakage to the gears which would result from an interengagement of the starter and the motor gears while the latter is in motion.

AUTOMOBILE LOCK.—H. M. Cloude, McMillan and Boone Sts., Cincinnat , O. An object is to provide a device by means of which the theft of cars having manual starting cranks may be prevented. A further object is to provide a device which is carried on the front axle of the car and by means of which the crank handle is securely held in an inner position in which the clutch members are directly connected, thereby locking the engine to the axle.

TIRE RIM.—S. P. Michael, 258 E. Barner St., Frankfort, Ind. The invention relates to a rim adapted to constitute a demountable rim, and including as a part thereof a quick detaching tire-holding element, whereby to detach the tire without demounting the rim as a whole or disturbing the parts of the rim other than the detachable tire element. The rim is so constructed that the attaching or detaching of the tire, or the mounting or the demounting of the rim, may be effected without the use of extra wrenches, without hammering, and with the minimum expenditure of time and work.

Designs

DESIGN FOR A TEXTILE TRIMMING.—E. F. Eisinger, 256 5th Ave., New York, N. Y. The invention relates to an ornamental design for a textile trimming. The figure shown in the patent is a plan view of a portion of the design.

Note.—Copies of any of these patents will be furnished by the Scientific American for ten cents each. Please state the name of patentee title of the invention, and date of this paper.

The Current Supplement

WHAT is electricity? is a question frequently asked, but difficult to answer, for it does not manifest itself to a special sense as do sound and light. We see effects produced by electricity, but we cannot see what produces these effects. An article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2179, for October 6th, on *Mechanical Analogies in Electricity* will be found extremely valuable and interesting in enabling us to visualize electrical phenomena. Another article in this issue of wide practical interest to the public is *The Blister Rust of the White Pines*, which tells of the work being done by the Federal Government and many States to fight a disease that is seriously menacing one of our most valuable timbers. It is illustrated by many excellent photographs. Hosts of people are interested in questions of astronomy but are deterred in the pursuit of their studies by the lack of a suitable instrument with which observations can be made. That a practical telescope is within the reach of many an amateur is shown in a particularly valuable article on *The Making of a Six-Inch Reflecting Telescope* which describes in detail how such an instrument can be constructed by any amateurs who have a fair amount of mechanical ability. It is fully illustrated by diagrams explaining the various processes involved. At a time when all food problems are engaging the attention of everybody an improved process for making a superior bread will be generally acceptable, and this is described in the article on *Salt-rising Bread*, which is accompanied by several illustrations. *Heat Treatment of Metals* is another subject that will interest many, as these processes enter largely into a multitude of mechanical processes. Other articles of value in this issue include *The Cause of the So-called Pole-effect in the Electric Arc, Marching Fractures*, which deals with injuries to the feet that are found among soldiers, and is accompanied by illustrations; *The Art of Living* and *Inadequacy and Inconsistency of Some Common Chemical Terms*.

Where the Dirigible Has Advantage Over the Aeroplane

THE designer of the United States Navy's first "Blimp" type dirigible has some very decided views concerning the advantages of the lighter-than-air craft over the aeroplane. And since he has designed a large part of the British and French lighter-than-air craft now engaged in coast and harbor patrol, before coming to this country, his views should carry considerable weight.

"Your government is thoroughly alive to the possibilities of the lighter-than-air craft," he tells us. "Its advantages for certain purposes over the many types of aeroplanes and seaplanes lie in the fact that it answers the requirements of both. The pilot is the complete master of its speed and direction. He can remain stationary for hours at a time, in still air, or he can attain a speed of forty-five miles an hour under the same conditions. When the wind blows the big bag becomes part of it, and moves at the same speed. If the pilot wishes to change his course from that of the wind, he opens the gas cocks and seeks a lower stratum of air or throws out sand or water ballast until he rises to a higher stratum, where he can again pursue his course at will with his powerful eight-cylinder power plant. You cannot do this with an aeroplane: you are either rising or falling, and at the same time maintaining a high speed.

"The dirigible is just as big a part of the war machine today as it ever was. In fact, its possibilities are limitless. The attempts of the German government to use it as a terrible offensive machine are well known. The consequences are also well known. But the German government has yet to realize that the dirigible, because of its vulnerability, is not an offensive machine—at least in its present construction. But as a scout cruiser over harbors and coast lines it has no equal. Its radius of vision is greater than that of any ship, and, at heights to which it can ascend, it is virtually safe from an explosive shell that

might be directed at it from a hostile ship.

"The chances of a hostile warship ever approaching within range of the balloon are too remote to even deserve consideration. Therefore, let it be remembered that the dirigible in its present form is really a patrol boat of the air. The United States with a big fleet of dirigibles could keep better watch over its shores than it could with ten times the number of ships.

"The dirigible is no car for a student. For instance, you might be flying serenely along in the sun and suddenly the sun slips behind a cloud. You find yourself falling rapidly. The cooler air has caused the gas in the envelope to contract. Then again, in experiments I have found that in the sun-lighted air you can cause the dirigible to drop suddenly by simply placing a leaf on top of it. Then still, at night, when the air is cool, the ascent or descent of the balloon can be controlled by the direction of a powerful searchlight upon the bag."

All of which means that there is still a big field for the dirigible. Because the Zeppelins have not proved a great success in the present war should not serve as a condemnation of the dirigible type; for the Germans have certainly misapplied what is really a worthy class of aircraft.

Development of Aviation Engines

(*Concluded from page 247*)

ical motor can go farther into enemy territory than those propelled by a more wasteful power plant.

Meeting the Extraordinary Conditions of the Higher Altitudes

One of the most important conditions that must be met by the aeroplane engine designer is compensation by some means in the motor construction, to allow for the effect of increasing altitude. The difference in the power developed at sea level and that produced a few thousand feet in the air may not be very startling; but when the change from a low to a very high level takes place in a short period of time, as is possible in some of the planes of recent development which climb 10.000 feet in seven or eight minutes, the change in altitude produces a striking effect. The reason for this is that the air becomes more rarified as the altitude increases and the atmospheric pressure reduction is approxamately one-half pound for each 1.000 feet increase. If the pressure at sea level is 14.7 pounds per square inch and that at 10,000 feet altitude is but 10 pounds per square inch, it will be apparent that the power developed by an engine at this height would only be about two-thirds of that produced at sea level. Because of this, the builders of aeroplane motors are forced to consider the effect of a decreased efficiency of the motor on the flying abilities of the machine. At high altitudes, the plane operates in strata of very cold air, and this low temperature has its influence on the motor as it may produce sudden contraction of expanded parts and produce stresses in the important engine components which may be the cause of various unexplained engine failures that have occurred in the past. The efforts of designers have been devoted mainly to making such changes in the engine and carburetion system as would increase the efficiency at high altitudes, and one of the obvious methods is to increase the compression pressure so that it is abnormal at sea level and about normal at high altitudes. The combustion chamber space may be reduced so initial compression pressures of about 120 pounds per square inch may be obtained on the ground. Of course, it is not possible to run an engine of this type with full throttle without pre-ignition at sea level, but at 10,000 feet elevation the compression pressure would be but slightly over 80 pounds and the power output normal even with a wide open throttle. The full power of the engine is not needed when flying at low altitudes and it is only working at full capacity when conditions make it imperative to obtain all the power possible, as in flying at great heights.

Aeroplane engines may be divided into two main classes, the medium and the high speed types. In the former, the propeller is usually attached directly to the engine crankshaft and speeds of rotation seldom exceed 1,400 r.p.m., while in the latter the propeller shaft is driven by reduction gearing and the crankshaft may turn over 2,000 r.p.m. to produce a propeller speed of less than 1,500 r.p.m. The rotary engines are always of the direct connected types because much power will be consumed in overcoming resistance to cylinder rotation if the engine turns much faster than 1,200 r.p.m. Even at this low speed, the nine cylinder Gnome Monosoupape, which weighs but 300 pounds, will deliver about 110 horse-power. While most aviation engines will give about .2 horse-power for each cubic inch piston displacement, some have given as high as .3 horse-power per cubic inch displacement.

What Makes An Aeroplane Engine So Costly

The importance of using the best of materials for the engine parts subjected to great stress has been strongly emphasized, and it is also imperative to do very accurate machine work. Clearances in aeroplane engines are much less than in those intended for automobile work, so they are very costly to manufacture. As an example, it may be of interest to mention the machine work on the Gnome engine cylinders which are produced from a solid block or cylinder of chrome nickel steel weighing about 90 pounds before fabrication and but 5½ pounds after the cylinder is completed. All of the material must be removed by ordinary and slow machining processes, such as lathe work, and about 85 pounds of the expensive steel is removed in the form of chips which have only scrap metal value. The finished cylinder wall is only 1-16-inch thick and the cooling flanges are as thin as paper. In some of the water cooled engines, the cylinders are machined from steel forgings, and the water jackets, of extremely thin metal, may be applied by a plating process or may be built on by the oxy-acetylene welding torch from light stampings. Connecting rods and similar parts are "hogged" out of the solid bar, and crankshafts are hollowed out to secure maximum lightness. This explains why the ordinary aviation engines cost more than complete automobiles of equal power.

Various ingenious combinations of rotary cylinders have been devised to secure a high power output for small weight, and engines of this type in 14, 18 and even 22 cylinder forms have been built. Rotary engines operating on a one-throw crank always have an odd number of cylinders in order to secure an evenly-spaced explosion

Characteristics of American Aeroplane Engines

Motor	No of Cyl.	Type	Rated H.P.	Weight	Bore	Stroke	Cooling	R.P.M. Crank-shaft	Gas Con. perH.P. hour	Oil used perH.P. hour
Curtiss OX2	8	V	100	425	4¼ in.	5 in.	water	1,400	.59 lb.	.035 lb.
Curtiss VX3	8	V	200	660	5 in.	7 in.	water	1,400	.73 lb.	.031 lb.
Curtiss V4	12	V	300	1,125	5 in.	7 in.	water	1,400	.612 lb.	....
Duesenberg	4	Vert	120	455	4⅞ in.	7 in.	water	2,100	....	....
Gen. Veh. Gnome	9	Rotary	100	272	4.33 in.	6½ in.	air	1,200	.72 lb.	....
Hall-Scott A7	4	Vert	90	410	5 in.	7 in.	water	1,370	.47 lb.	.037 lb.
Hall-Scott A5	6	Vert	125	592	5 in.	7 in.	water	1,300	.507 lb.	.028 lb.
Hispano-Suiza	8	V	154	455	4¾ in.	5 in.	water	1,500	....	....
Sturtevant	8	V	140	600	4 in.	5½ in.	water	2,000	.54 lb.	.043 lb.
Thomas-Morse	8	V	135	572	4 in.	5½ in.	water	2,000	.59 lb.	.053 lb.
Wisconsin	6	Vert	140	637	5 in.	5½ in.	water	1,380	.662 lb.	.039 lb.

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effect, though an even number of cylinders are possible with a two-throw crank. In order to secure a uniform power application, engines of the fixed cylinder type have been made with three and four banks of six cylinders acting on a common six throw crankshaft, so that 18 and 24 cylinder power plants are obtained without having greater overall length than the conventional six-cylinder forms with which all are familiar. Engines of this type have been made in 500- and 600-horse-power sizes, and in weights as low as 2.5 pounds per horse-power obtained for water-cooled engines.

Emulating the Automobile in Today's Aeroplane Design

The engine installation in modern airplanes is not very much different than that in automobiles, as the radiator is mounted in front of the engine so it can be cooled by the propeller slip stream. The fuel tank is mounted back of the engine, the fuel feed being by gravity flow in those forms where the tank is placed higher than the carbureter, and by air-pressure feed if the tank is placed low in the fuselage. The engines are bolted to substantial bed timbers in the fuselage, and the excellent balance of most aeroplane engines insures that the power plant will function without excessive vibration. Aviation engines require constant care to insure that they will operate reliably. Frequent inspection of the mechanism is necessary. While engine stoppage in mid-air does not necessarily result in damage to the plane or pilot when the machine is piloted by a skilled aviator, a forced landing may inconvenience the operator. So every precaution is taken to keep the engine in the best of condition. After an engine has been used for a certain number of hours, it is completely dismantled, all parts cleaned, bearings refitted, valves reground and retimed and all parts completely overhauled. Rotary engines usually are overhauled after 40 to 50 hours operation, while eight and twelve-cylinder V-forms may run as long as 70 hours without requiring this attention. This performance is very good when one considers that such engines are practically always operated at full throttle and called upon to develop their full power while the plane is in flight.

Space does not permit a description of leading American motors, but their main characteristics may be readily ascertained from the given herewith tabulation.

Aeroplanes in the Making

(*Concluded from page 246*)

are used, which carve the block to the required shape by making use of a master model and in this manner eliminate much of the costly labor incidental to propeller making. The carving operations completed, the propeller is finished off with a metal hub piece and a glossy paint of varnish. Each propeller is carefully tested for accuracy of design and balance; and, needless to say, any knots, dry rot or other flaws in the wood, which might weaken the finished propeller, are almost certain to be detected during the carving operations.

With fuselage, wings and propeller ready for assembling, there still remains a number of other things to be manufactured, such as the spars, landing chassis, upholstery, fittings and so on, not to mention the engine, which is either made in the same shop or purchased from an engine builder. But once these components are at hand the assembling begins. The engine is placed in its proper position in the fuselage; the upholstered seats go into their respective cockpits; the instruments are mounted on the instrument board; the rubber-tired landing chassis is secured to the fuselage; and, finally, the guy wires or stays are strung and tightened up until the aeroplane is rigid and true. This last operation is a most important one, and consumes considerable time.

The aeroplane, now completed, is sent to the testing grounds where it soon soars away on its initial flight. Later, it is dismounted, packed into a number of cases, and shipped off to distant aerodromes at home and abroad.

Completion of the World's Greatest Cantilever Bridge

(Concluded from page 250)

no rocking movement at its points of support, but provision had to be made for longitudinal movement owing to thermal expansion of the structure. This it was estimated, would amount to $3\frac{1}{16}$ inches at each corner. To limit the longitudinal movement of the shoes blocks were provided, as shown at *A A*, Fig. 2.

When the span was floated the load was taken off the lifting girders, but they were lifted by the span by means of a pair of depending links. This freed the sliding bearings, and the filler plates were then removed while the blocks A were turned around to the position shown in Fig. 3 so as to bear against the shoes on the span and prevent sliding movement. After the span had been moved to position between the cantilever arms, the chains had been made fast to the stub links attached to the lifting girders and the jacking started, the load came upon the rocker plate, as indicated in the cross-sectional view, Fig. 4.

The rocking plate allowed for slight tilting due to unevenness in operating the lifting jacks or to slight swaying of the span. If any accident had occurred at the rocker plate the span would merely have dropped very slightly upon the flat bearings at either side. Furthermore, because the bearings were flat there would have been no tendency to kick the girder out from under the span. However, the use of nickel steel in place of a steel casting made it practically certain that no breakage could occur at this point.

The other details of the lifting mechanism were practically the same as employed last year. Mooring trusses hung down from each cantilever arm to keep the span from swaying while it was being raised. The same hydraulic jacks were used, operating between a pair of jacking girders. The lifting chains, were heavier than last year—consisting of flat steel plates, $1\frac{1}{2}$ inches thick. They were first secured to the upper jacking girder. Then, when the jacks had raised this girder to the limit of their stroke, viz., two feet, the chains were secured to the lower jacking girder by means of pins, and detached from the upper one while the latter was lowered to take a fresh hold. In order to insure against accident last year, two hand-operated screw jacks were arranged to follow up the work of each pair of hydraulic jacks. This year, four hand-operated screw jacks were employed instead. However, at no time did the screw jacks actually have to carry the load, because the hydraulic jacks worked perfectly. Each lift of two feet, including the time taken for preparation for the next lift, occupied on the average 14 minutes.

The work proceeded regularly, without a hitch, during daylight hours only. On the third day the huge span was finally lifted into place. The permanent hanger eye-bars projecting from the span and those depending from the cantilever arms were interlaced and a 12-inch pin was driven home at each corner ; a gang of 10 men hammered it in.

The last pin in place, the crisis was past; the great engineering battle was won.

One of our photographs shows the span in final position with the mooring trusses still hanging down from the cantilever arms. These, of course, are to be removed. For the sake of appearances, there will be short members connecting the top chords of the cantilever arms with those of the span. Two of these are shown in place at *A* in the photograph. They will serve no engineering purpose and are not required for strength. However, they will carry a footpath for inspection purposes, along the the upper chords of the bridge.

A good deal of credit is due for the despatch with which this second span was constructed. It was a duplicate of the first one, measuring 640 feet in length, 88 feet in width, and weighing 5,400 tons. The steel was rolled, machined, and erected in ten and one-half months, a shorter period than was occupied by the construction of the first span, which, in view of the war-time demands for labor and materials, is a creditable performance.

A Three Years' Flying Experience

(Concluded from page 244)

heights insufficient for the machine to get out of its side-slip before striking ground. Others strike the ground at the later stage, usually a nose dive, but in some cases a spin. If sufficient height remains after the machine assumes a nose dive there is no reason why it should not be pulled out and a normal glide resumed, but in the other event, although it is possible to get out of a spin, it is far more difficult a proposition than the instinctive maneuver of pulling up out of a nose dive.

A spin is the extraordinary turning movement that some machines only too readily take up after being stalled on a turn or being turned too flatly even with plenty of flying speed. This is due to the machine suddenly meeting the air a great deal out of the parallel with its longitudinal axis either through side-slipping, skidding, or yawing in the air. Having had more than one involuntary spin, but having been fortunate enough to have sufficient height to get out again, I feel the matter is not to be treated too lightly. The position a machine assumes in a spin is a rapidly revolving side-slip or a fairly steep spiral dive, with this rather serious drawback that the more one tries to pull it up by means of the elevator the faster it spins. No matter how high one is, if one persists in trying to pull it out in a normal way, it will remain out of control because the elevator has now become the rudder, and instead of pulling it out, increases the speed of turning. If the controls are abandoned, the machine will come out of its own accord, but personally I have always found the best and quickest remedy for spins is to straighten the rudder and shove the joy-stick forward; a clean nose-dive will then result out of which the machine can be pulled.

I think in the matter of spins, prevention is better than cure, and it is up to the designers to see that their machine is of the non-spinning type, as however, clever and quick the pilot may be in applying his pet remedy, he may not have height enough to do so, and the results are usually disastrous.

The errors of judgment which are made in landing account for crashes galore, but these, fortunately, are usually a small matter compared to those made in the air, seldom resulting in more than a smashed landing chassis. Flying experience is the only remedy for this particular fault.

Landing with the wind will sometimes end in a crash through the machine over-running the limit of the landing ground; while landing side to wind will buckle wheels and wreck chassis. Neither of these troubles is always the direct fault of the pilot.

An easily distinguishable standard type wind-vane on every recognized landing ground would considerable lessen crashes from these causes.

Faulty Construction

Accidents directly due to faulty construction of the airplane are, fortunately, comparatively rare, as when they happen the results are so often fatal. They occur, however, even on standard types. In some cases the airplane is not entirely at fault, as in these days of heavy high speed efficient machines with so little head resistance and which attain colossal speeds on diving, it is such an easy matter for the pilot to increase the load beyond the highest factors of safety. One has only to consider the load on the wings of a machine dived at 160 m.p.h. when it is pulled out with a heavy hand.

Constructional failures of machines in the air can sometimes be traced to damage inflicted by imperfect landing, usually to the back part of the body in the region of the tail skid. This gets overlooked and subsequently the tail gives way under any extra stress while flying.

I should like here to be permitted to make a suggestion for the consideration of our chairman for what it is worth, *i.e.*, that a detailed record be kept of every engine failure, forced landing or accident of every kind and description that happens, at any rate, at all home stations. These

records to be collected and classified so that valuable data may always be available. However, some such system as this may already be in operation.

I now come to a few points which might be brought forward from my experience with instruction of pilots.

Medical Tests for Prospective Pilots

I think that a great deal of time and expense might be saved if some form of medical test were applied to prospective pilots, such as I understand is done in France, where the effect of sudden shocks upon the system of the candidate is recorded by mechanical means, and other tests are made which are supposed to give a fair indication at once of the medical fitness and the possession of the necessary qualities, such as nerve, judgment, and the presence of mind required for the making of a pilot.

There are many pupils on whom a lot of time and material has been wasted in the endeavor to make pilots of them who simply do not possess these ordinary qualities, and it is not until they have had smash after smash that it is discovered they simply have not got it in them. Now the French method should weed out the non-suitable candidate beforehand.

Personally I consider that the nearest equivalent to the art of flying is that of motor-car driving; a person who thoroughly understands and who can drive a car really well should possess the qualities required for piloting an airplane. General Brancker, in the paper he read a short time ago before the Society, mentioned a good horseman as the type possessing the necessary qualifications. I agree that good hands, a good head, steady nerves and judgment are essential qualities all of which should be found in a good motorist, with this advantage, that the good motorist is more likely to be naturally mechanical, a faculty inborn and not easily acquired, and so important in the matter of flying.

Types of Airplanes for Instructions

Time and material would be saved, in my opinion, if the modified "penguin" type of machine were more generally used for the very earliest training. I refer to the small-powered machine, incapable of leaving the ground, but designed solely for taxi-ing about the aerodrome, which was generally in vogue at the Blériot Schools before the war. On this machine the pupil can be loosed off alone immediately after preliminary explanation with comparatively no risk, and at the same time he would get used to controlling his engine. have plenty of practice in the use of that important control, the rudder, and lastly, but not least, he would have to be left to his own resources, use a little initiative, and get used to the noise and wind from his motor. This type of machine might be modified in such a way that the other controls might be brought to play an active part in piloting the "penguin" over the ground. The whole body and wings might be supported independently of the landing chassis (or rather the rolling chassis) in a sort of gimbals, so that it could be banked and elevated by the control lever while running along or turning. I think an hour's taxi-ing on a machine of this type would, as a preliminary, be of more assistance than the same amount of dual control, as the pupil would know at least more about the use of his rudder.

The best type of airplane to use for instruction in actual flying and the question as to whether it should be stable or not is a very debatable point. I do think, however, that the less efficient within certain limits the early training machine is, the better and sounder will be the elementary knowledge and experience gained by the pupil. Such experience is likely to be very valuable when, later in his career, he is confronted with engine failures or similar predicaments, where his reserve of engine power will no longer cover up his multitude of sins in piloting. To illustrate this point, let us assume that there are two pilots, A and B. A has qualified for his Aero Club Certificate on a box-kite, *i.e.*, early Henry Farman type biplane, fitted with 50 horse-power Gnome. B gets his certificate on a much more powerful ma-

chine, one that can climb quicker, and can even be turned and climbed a bit at the same time. He knows this is so because he has done it on his last flight. But A finds that to get round really comfortably on his he feels compelled to drop the nose a little, as it feels a little sloppy otherwise. At a later date, on valuable service machines, both A and B have engine failures. A lands successfully, B crashes badly through turning too flatly. A had learned from the beginning that he was always on the safe side in dropping her nose a bit on a turn; B always thought it unnecessary.

Personally, I do not think that the stable machine is the best for training. If it is considered so on the score that once in the air it will look after itself and so reduce the chances of the pupil crashing, then we have only to assume, for the sake of argument, that a self-landing training machine has been devised that will automatically land itself correctly, do away with the smashes on landing, and ultimately, with a few more improvements, all the pupil need do would be just to sit still and take the air, as everything would be done for him, but after many hours of joy-riding on this super-school machine he would have learned very little about piloting. For securing Aero Club Certificates for pupils at so much a head as a commercial proposition, this sort of machine might be excellent, but the unstable machine should be used as the basis of training to get the best results in the end.

The Use of Instruments for Training

I now come to another question, over which there is a deal of controversy. It is the use of instruments for training. I consider instruments as valuable accessories to any machine, but only under certain circumstances are they necessities, and in training they should not be regarded as indispensable. It is the wrong system, in my opinion, for the pupil to be made to rely on them too much. Although flying is largely a mechanical procedure, there is a tremendous lot of the personal sensation and feel that the pilot should acquire which, when once acquired, will take the place of practically any instrument devised. For instance, could an ice-skater learn to do the outside-edge merely by looking at a bubble of a spirit-level fixed in front of him? I should say no, but once he had acquired the feeling that he had correct balance, which only practice can give, he will make his sharp turn on the outside-edge at the correct angle better than any instrument could show him. Therefore I say let the pupil acquire without delay that naturally instinctive feeling so absolutely essential for a good pilot. When he is taught to rely on his instrument too much to climb, turn, or even try to land, he will be long, if ever, in acquiring the art that will make him independent of instruments.

Personally I seldom use an instrument as an assistance to piloting. Do not assume that I am sneering at instruments; in fact, as I have stated, there are times when they are a necessity. In fact, I am going to suggest that one more instrument be fitted as a standard equipment, an instrument to reduce the risks connected with flying in clouds.

Flying Through Clouds

It may not be generally known that there have been such a large number of fatal accidents during the last three years entirely due to flying through clouds, and I consider this subject wants going into pretty carefully. The accidents to which I refer have not been questions of a want of height; the machines have become hopelessly out of control. I will give you an instance which happened to myself a few weeks ago in the West of England. You will then realize why I consider this is a serious matter requiring particular attention. I set out on a very cloudy, windy day to do a test climb to 10,000 feet on a late type two-seater. I had so often on previous occasions succeeded quite comfortably in reaching this height in spite of cloudy, overcast days by pushing up through the clouds, usually only a matter of a few minutes, into bright sunlight and

the bluest of skies, and, after reaching the desired height, coming down again through the clouds, having flown by compass and time. On this particular day, however, the wind was very gusty, and on reaching 1,200 feet we got into a dense rain cloud, but carried on to beyond 5,000 feet, still in the cloud, when the compass apparently began to swing (really it's the machine that begins swinging, not the compass), and efforts to check the compass had the effect of causing it to swing more violently in the other direction. The air speed then rushed up far beyond normal flying speed; all efforts to pull her up checked her only slightly; then the rudder was tried, back went the air speed to zero; there was an unusual uncanny feeling of being detached from the machine, and I knew her to be literally tumbling about in the clouds. All efforts to settle down again to a straight flight seemed to be unavailing, until we emerged from the cloud very nearly upside down. Assuming control again was then an easy matter. This sort of thing has happened to me more than once, and, in the Flying Corps vernacular, "it puts the wind up you," and it has happened many times with other pilots. In some cases they emerge from the clouds in a spin, others are known in which the planes have collapsed under the strain of the sudden pull-up from the vertical nose-dive. A few days ago a squadron commander told me that on one occasion when in France everything loose in his machine fell out while in a cloud. A week or so ago, on the South Coast, a machine disintegrated in a cloud and the main planes landed half a mile from the body. From my own experience this is a very unpleasant state of affairs, and in consequence I avoid clouds when possible. Let us try to examine the cause of this. First of all you must realize that in a cloud you see nothing whatever but your machine around you. There is no fixed point visible. The only means by which you can tell if you are flying in a straight course is by your compass and your air speed. The compass should give you your direction horizontally, your air speed your direction vertically. The first thing that happens, and very readily, too, if windy and bumpy, is that your compass card will begin to move slightly. It really appears to you that the compass was suddenly affected by the cloud, and you are still flying straight ahead. How often you hear a pilot say that as soon as he got into a cloud his compass started spinning. The moment the compass starts moving it requires extremely delicate ruddering to get it back to a steady position; in fact, one invariably over-corrects the compass movement and so the trouble begins. Once the compass starts on a good swing I have found it nearly an impossibility to get it steady again until out of the cloud. Before your compass starts to move your machine has already started to turn. You rudder the opposite way to check it, over-correct it, and turn sharper the other way on to a bank turn; then the nose drops and the speed goes up. Pulling back your elevator lever has little or no effect, for if you are banked above an angle of 45 degrees the elevator becomes the rudder. All this occurs without the pilot being in the least bit aware of the position that his machine is taking relative to the ground. The instruments available are of little service once he loses his control.

Of what use is his air speed indicator to him indicating 150 m. p. h. if the machine is on a spinning spiral and he imagines that he is merely descending too fast on a steep, straight glide? He naturally tries to pull up, but with no effect. The bubble does not help him, as centrifugal force will send that anywhere. It may be argued that if a stable machine is left alone under these circumstances it will right itself eventually and assume a normal glide. It very likely would if the pilot could steel himself to let it entirely alone, but before it did so it would have to be left to do a sheer vertical nose-dive for some moments, and in these days of big weights and little head resistance one is liable to attempt to pull out too suddenly from the dangerous high rate of speed attained on this dive. What I want to see fitted is an instru-

ment which will show a constant vertical or horizontal line and be independent of centrifugal force. I have no ideas upon the subject nor suggestions as to how this is to be brought about, unless something in the nature of a small gyroscope driven by an air-screw could be employed in some way to meet the requirements of flying in clouds, but until something is provided so that the pilot can see a fixed line, I think we shall continue to have accidents from this cause.

Flying at Great Altitudes

There are lots of other points that I should like to touch upon, but as my time is getting short I shall now deal with the subject of flying at great altitudes as I have found it. The most marked development in the modern machine is its extraordinary capacity for climbing to a great height in a short time. At the beginning of the war the average height flown on active service was 4,000-5,000 feet, simply because few of the machines then in use with the impedimenta carried could get much higher. Today a height of 20,000 feet is, I believe, on certain occasions reached, and it is fairly certain that if progress continues at its present rate, heights a great deal beyond this figure will be reached as a usual thing. These great altitudes bring forward many difficulties which will have to be seriously considered. The first trouble in the winter will be the extreme cold to which the occupants will be subjected unless they are protected by special cowling, which will gather in the warmth given off from the engine. This, to a certain extent, is the natural advantage obtained in the tractor. The question of the difference in the comfort of machines in this respect was shown to me in a very marked manner last winter. I was testing the fall-off of engine power at a height on a tractor two-seater, in which it was specially arranged that the warm air from the radiator and engine passed along the body to the pilot and then to the passenger, and although at a height of over 21,000 feet with the thermometer below freezing at ground level, I did not suffer in the least from the cold, neither did my passenger, who sat behind, complain until we shut off to descend. As a contrast to this, a few days later I was on a single-seater at an altitude of 17,000 feet, and although it was a tractor with a rotary motor, I suffered intensely from the cold, and became so numbed that my vitality must have been something akin to a dormouse under the snow, and, in spite of being well gloved, I had frostbitten finger tips, which pained for many days afterward. Surely this is a very inefficient state for a pilot at the front to have to take on an air fight or other exacting work? Put two pilots up to a great altitude, one kept well warmed and comfortable, the other half dead with the cold, and it would be easy to surmise which would be most likely to do the best work.

I really belive it is more by accident than design that the pilot or passenger has benefited at all in the past from the heat of the engine, with the exception perhaps of the late S. F. Cody's machine. He purposely placed the radiator of his pusher in front of the pilot to keep him warm. I know from my experience when flying in France in the cold weather that the discomfort owing to the extreme cold became intense when flying only at 6,000 feet on a two or three hours' reconnaissance flight. This is a point to which designers should give attention, especially as machines are now easily capable of reaching great heights. During summer weather conditions would probably be tolerably comfortable, but in winter it would be well nigh impossible unless better arrangements are generally made.

Cold also affects the engine pretty seriously. This is more noticeable with the water-cooled type. Unless some provision is made for blanketing the radiator surface at heights it becomes far too cold for efficient running. Cases are known of the freezing of the water system on a descent from a great height, with pretty serious results to the engine, as well as the difficulty of getting the engine to run again efficiently through being too cold to effect a landing. In the future war machine the pilot must have a very wide range of control over the water-cooling system.

Effects Due to Flying at High Altitudes

I will now touch lightly on effects that I have experienced on high flights. I have found the effect of high, *i.e.*, rarefied, air to be felt slightly at about 10,000 feet increasing with the altitude. Breathing becomes affected, respiration shorter and quicker, there is a curious oppressive sensation and a bulging feeling in the head until the height of about 20,000 feet is reached. I am told by a medical friend who has made rather a study of the subject that there is always a risk of a sudden collapse, and oxygen should be used whether the aviator feels fit or not. Of course, the effect felt varies considerably with individuals, and with the state of one's health. About eighteen months ago I suffered slightly with my heart, and found I could not get very high without feeling giddy, and after returning from a flight to 12,000 feet I had palpitation which lasted until the following day. In consequence I had to abandon high flying until treatment got me fit again. This year I have made a number of high flights and have felt no ill effects whatsoever; in fact, I find the more one gets accustomed to going up high the less the effects are felt. I am told that this also is the case in mountaineering. I can remember the unpleasantness of my first flight to 15,000 feet. It was very marked, especially the pain experienced in the drum of the ears on descending. The fact that a flight now to 21,000 or 22,000 feet does not have so much effect I put down entirely to acclimatization. I use oxygen as a precaution when ascending beyond 20,000 feet for the previously mentioned reason. A small bottle is carried, fitted with a special reducing valve, which is fixed in the body within easy reach of the hand. No special regulation is required as it is set to pass only the necessary amount of gas into the face mask which acts as a mixing chamber, with its inlet and outlet air valve. The apparatus weighs 16 pounds, and contains sufficient oxygen for one hour's continuous use. After reaching 20,000 feet I find it is only necessary to use the oxygen intermittently, and accordingly I simply hold the mask after turning on the gas over the mouth and nose and take a few breaths of it, perhaps every half minute. The effect on me is remarkable; most of the oppressive feeling vanishes, and, excepting for the unpleasant bulging feeling of the head, which you experience with a bad cold, the sensation is one of suddenly being again at ground level. The only after-effects upon landing from these high altitudes are that you seem to acquire a pretty good thirst, due, I suppose, to the use of oxygen. If the speed of climb continues to improve at the rate it has for the past three years, it looks as though aviators will become subject to what is known as "Caisson Disease," due, I am told, to the sudden reduction in atmospheric pressure.

There are many other points that I intended touching on in this paper, but I find that to do full justice to the subject it would occupy considerably more than the limited time at my disposal.

Electric Device for the Blind

A PARIS scientist, M. Chas. Lambert has devised a method of writing which will be very useful for blind persons, especially mutilated persons who have lost their hands or forearms, the reading of the signs being done by a specially designed electrical device. In the first place the characters composing the text are printed in Morse alphabet on the same method as is employed for producing letters in relief on letter paper, that is by printing with a thick paste which then solidifies and leaves a raised letter. This method now replaces the old embossing process where cost is an item, for it is much cheaper. The only difference from the usual Morse alphabet is to place the dashes vertically instead of horizontally. Reading of these characters can then be done by persons deprived of their hands, by the use of a very simple electric device which is run over the characters in relief which are printed with a special metallic ink.

SCIENTIFIC AMERICAN

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